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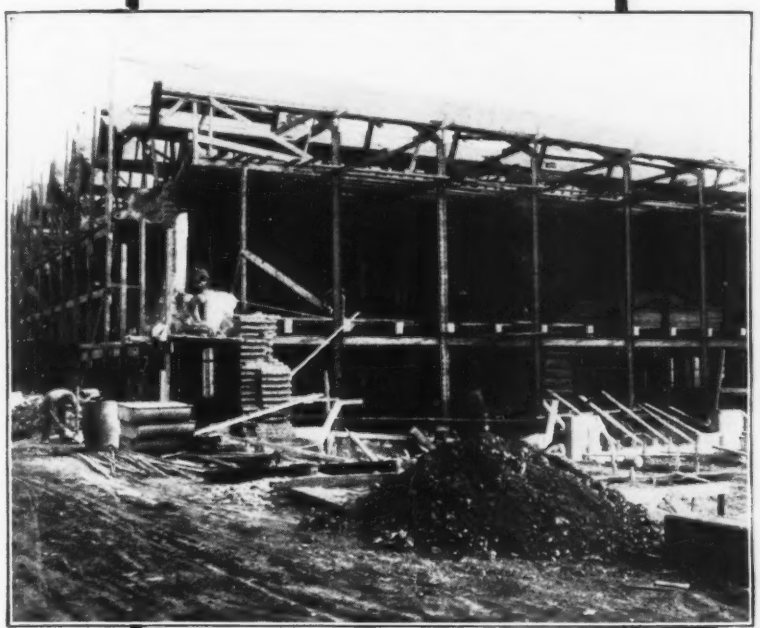

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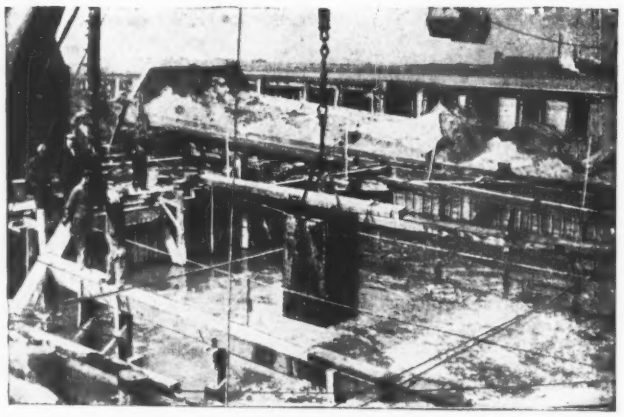

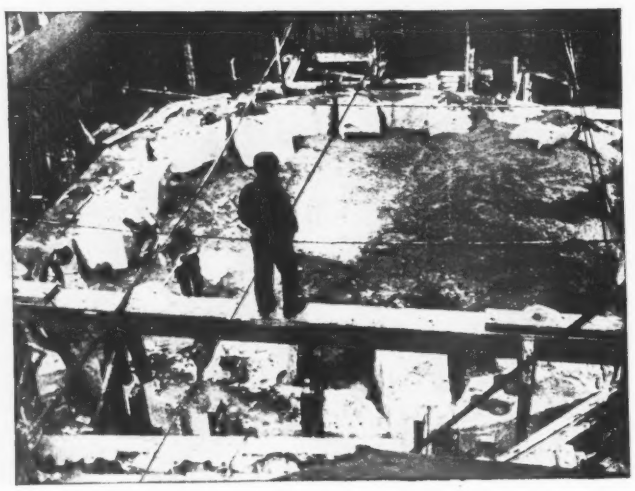

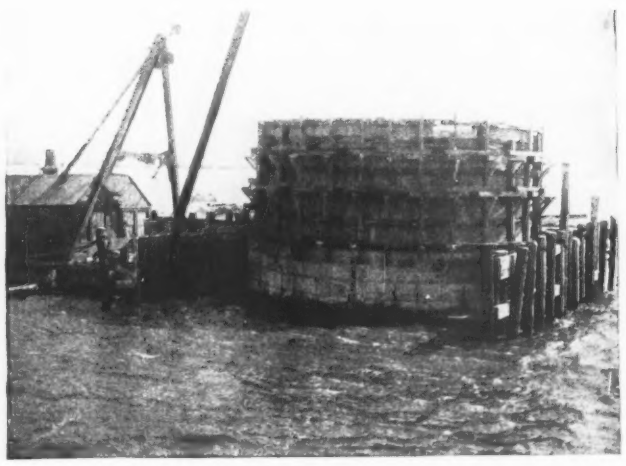

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Engineering News

CHARLES WHITING BAKER, *Editor*

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What The Buyer Needs To Know

Number Forty-Four

There was a book published not long ago that made such an impression on an advertising man of Chicago that he decided to advertise it at his own expense. He said that it was a book he had waited for so long and so ardently that he felt he must tell other people about it—induce other people to read it.

The book is called "CROWDS." Its author is Gerald Stanley Lee. And the book might be called a philosophy of modern business. It claims the world is waking up to the fact that the Golden Rule is practical, every day common sense.

Here is an interesting extract from "Crowds" which will give you an idea of its quality:

"In the United States some forty years ago, being a new country, and being a country where everything a man did was, in the nature of things, felt to be a first experiment, everybody felt democratic and independent, and as if he were making the laws of the universe just for himself as he went along.

There was a period of ten years or so in which every spool of thread and bit of dress goods—everything that people wore on their bodies or put in their mouths, and everything that they read, came up and had to be considered as an original first proposition, as if there never had been a spool of thread before, as if each bit of dress goods was, or was capable of being, a new fresh experiment, with an adventurous price on it; and before we knew it a moral nagging and edging and hitching had set in, and was fast becoming in America an American trait, and fixing itself by daily repetition upon the imagination of the people.

The shopping of a country is, on the whole, from a psychologist's point of view, the most spiritual energy, the most irrevocable, most implacable meter there can ever be of the religion a country really has.

There was no clergyman in America who could have made the slightest impression on this great national list or trend of always getting things for less than they were worth—this rut of never doing as one would be done by. What was there that could be done with an obstinate, pervasive, unceasing habit of the people like this?

What was there that could be done to touch the imagination of the crowd?

Six thousand women a day were going in and out of A. T. Stewart's great store on Broadway at that time. A. T. Stewart announced to New York suddenly in huge letters one day, that from that day forward there would be one price for everything sold in his store, and that that price would be paid for it by everybody.

A. T. Stewart's store was the largest, most successful, original, and most closely watched store in America.

The six thousand women became one thousand.

Then two thousand. Some of them had found that they finished their shopping sooner; the better class of women, those whose time was worth the most, and whose custom was the largest, gradually found they did not want to shop anywhere else. The two thousand became three thousand, four thousand, six thousand, ten thousand, twelve thousand.

Other department stores wanted the twelve thousand to come to them. They announced the one price.

Hardware stores did it. Groceries announced one price. Then everybody.

Not all the clergymen in America, preaching every Sunday for months, could have done very much in the way of seriously touching the imagination of the crowd on the moral unworthiness, the intellectual degradation, the national danger of picking out the one thing that nearly all the people all do, and had to do, all day, every day, and making that thing mean, incompetent and small. No one had thought out what it would lead to, and how monstrous and absurd it was and would always be to have a nation have all its people taking every little thing all day, every day, all they were buying, or that they were selling—taking a spool of thread, for instance—and packing it, or packing their action with it, as full of adulterated motives and of fresh and original ways of not doing as they would be done by as they could think up—a little innocent spool of thread—wrecking all their sins and kinds of sins on it, breaking every one of the ten commandments on it as an offering. * * *

It was A. T. Stewart, a very ordinary-looking, practical man in a plain, everyday business, who arrested the attention of a nation and changed the habit of thought and trend of mind of a great people, and made a candid, direct people, a people that went with great sunny prairies and high mountains, a yea and nay people, straightforward, and free from palavering forever. A. T. Stewart was accustomed in his own personal dealings from day to day to cut people short when they tried to heckle with him. He liked to take things for granted, drive through to the point, and go on to the next one. This might have ended, of course, in a kind of cul de sac of being a merely personal trait in a clean-cut, manful, straightforward American gentleman; and if Stewart had been a snob or a Puritan, or had felt superior, or if he had thought other people—the great crowds of them who flocked through his store—could never expect to be as good as he was, nothing would ever have come of it.

It is not likely that he was conscious of the long train of spiritual results he had set in motion; of the way he had taken the habit of mind, the daily, hourly psychology of a great people, and had wrought it through with his own spirit; or of the way he saved up, and set where it could be used, everyday religion in America, and had freed the business genius of a nation for its most characteristic and most effective self-expression.

He merely was conscious that he could not endure palavering in doing business himself, and that he would not submit to being obliged to endure it, and he believed millions of people in American were as clean-cut and straightforward as he was.

And the millions of people stood by him."

Engineering News

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New Bridge over the Rhine at Cologne

By Charles J. Kavanagh*

The question of bridging the Rhine between Cöln and Deutz has been under consideration for the last ten years but it was only in July, 1911, that tenders were invited by the municipality of Cöln for the construction of a new street bridge to replace the existing pontoon structure. The resulting competition led to no definite selection, the prize committee deciding on closer examination of the best five designs that none could be recommended as fulfilling all their requirements. A second call for designs, limited to the first five firms, was initiated early in 1912, with the result that the design submitted by the Maschinenfabrik Augsburg-Nürnberg A. G. was recommended for adoption, and was accepted by the municipality of Cöln, at a price of about 7½ million marks.

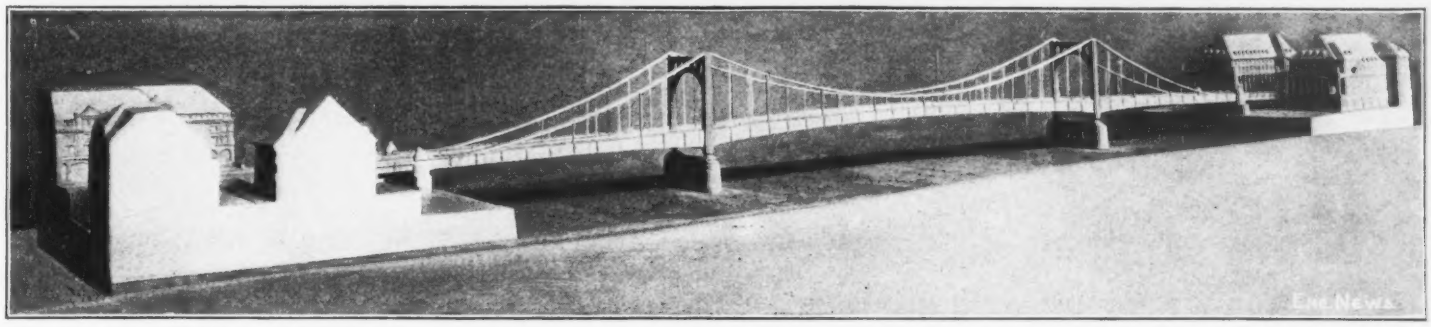


Fig. 1. Model of the New Rhine Highway Bridge Being Built at Cologne

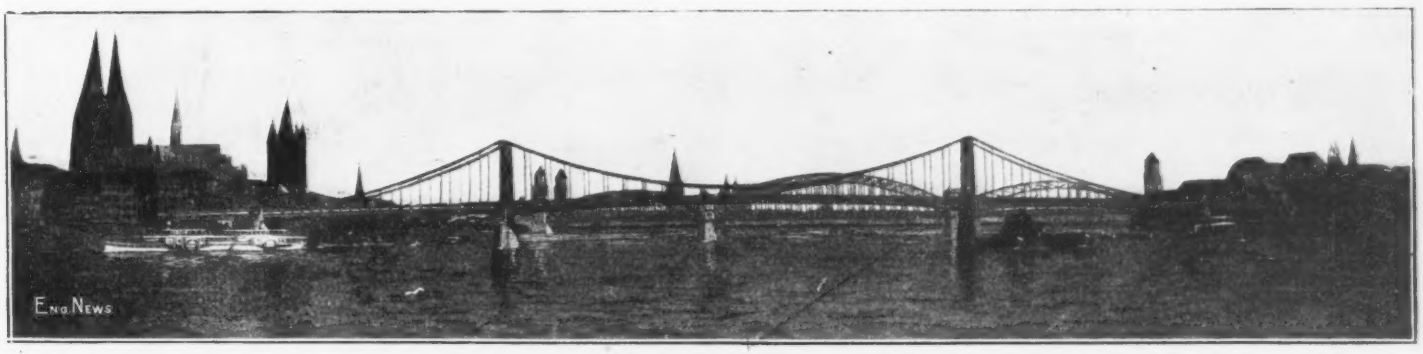


Fig. 2. The New Bridge over the Rhine at Cologne; in the Background Is the Recently Completed Six-Truss Railway Arch Bridge

It is the author's purpose in this article to set forth the chief points of interest in this structure, which embraces very many original features, and to center attention upon German methods of treatment. Before, however, proceeding further it is well to remark that in the invitation issued to tenderers the municipality of Cöln gave bidders to understand that what was wanted first and foremost was a structure in complete harmony with its surroundings, and even went as far as to indicate that a suspension bridge was best likely to fulfill the requirements. It should be added that designs for other types of bridge were also submitted, which were possessed of good esthetical merit and were appreciably cheaper, but the decision was for the more expensive suspension bridge as better representing the ideals of the prize committee.

General Design

The bridge is what may be termed a self-anchored suspension bridge. The suspension chains, instead of as customary being led to land anchorages, are anchored by bolts to the stiffening girder itself and put it under compression. The stiffening girder is continuous over four supports, so that the system as a whole is three times statically indeterminate. This will be the first bridge of large dimensions built in Europe (and perhaps in the world) of this type. The designers, prior to entering upon their calculations, made experiments upon a model bridge with a view to satisfying themselves as to how the stiffening girder would fail under compression. Under test loads the stiffening girder was found to cripple between panel-points, and the calculations for crippling were made upon this basis.

The entire width of the deck, including one roadway and two footways, is between the stiffening girders, so as to provide clear, uninterrupted passage from side to

*Engineer with Maschinenfabrik Augsburg-Nürnberg, Gustavsburg near Mainz, Germany.

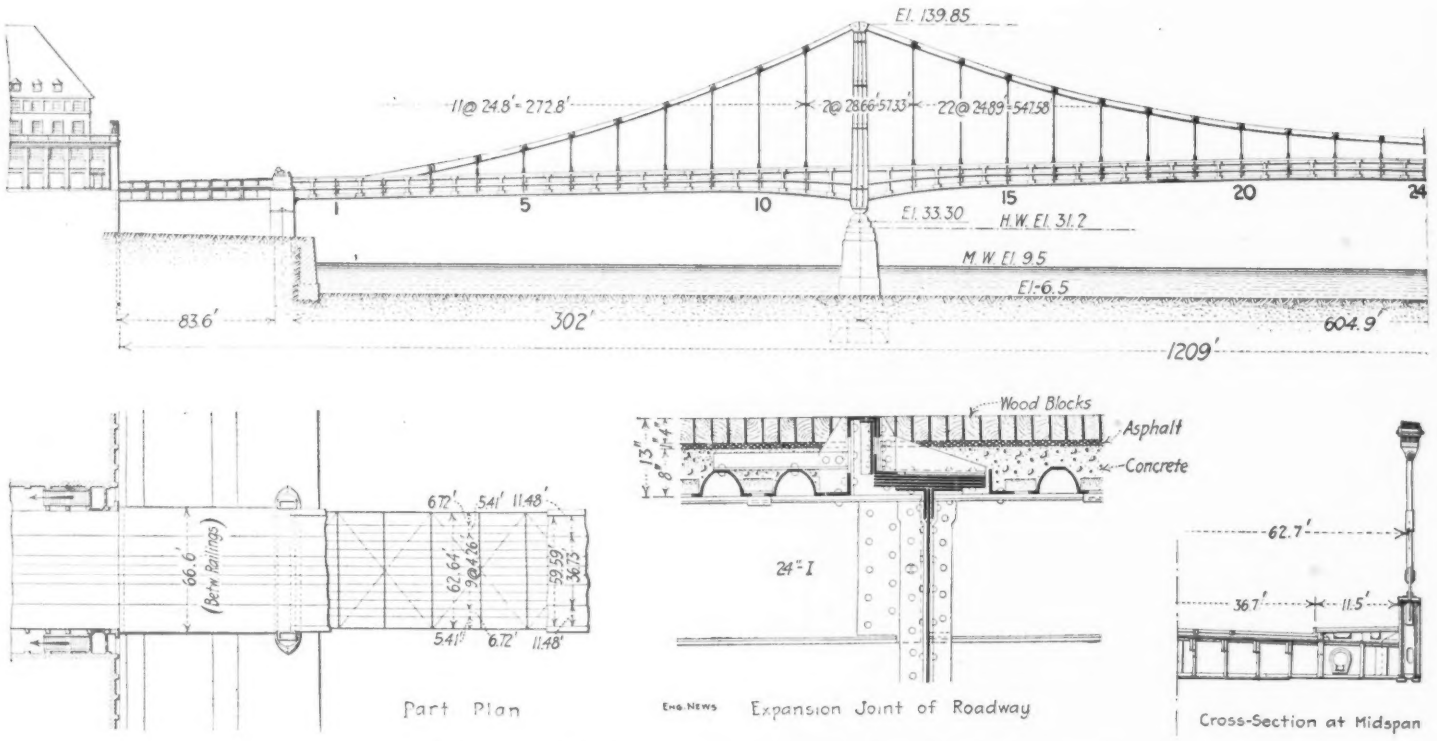


FIG. 3. GENERAL ELEVATION AND SECTIONS OF COLOGNE BRIDGE

(The stiffening girder is of box shape. The ends of the suspension chains are fastened to the girder by 24-in. pins. The bridge has no anchorages, and the reactions are vertical. At the towers, the girder passes through a slot in the post and rests on load-and-uplift bearings by means of rollers, allowing for expansion.)

side, giving pedestrian traffic the facility of crossing over at will from one footway to the other. As the stiffening girders project above the deck, this transverse communication would not be possible with footways cantilevered out.

Every consideration has been given in the design to providing an unobstructed deck and free outlook upon the river, two points of paramount importance from the point of view of the public. The stiffening girders are made to serve as bulwarks or railings; their top flanges are at the uniform height of 36 in. above the footways for the whole length of the bridge.

The fixed bearing of the stiffening girders is on the west pier; the other three bearings (east pier and both abutments) are movable longitudinally.

In contrast to an ordinary suspension bridge with land anchorages, the deformation of this structure due to loading has no appreciable effect upon the internal stresses—that is, the internal stresses are the same whether the calculations are based upon the original system diagram or upon the deformed one. Further, under a temperature change that is uniform in the whole bridge no additional stresses are induced, as the geometrical figure of the structure always remains similar.

The main dimensions of the bridge are as follows: The middle span is 605 ft. (184.46 m.), and the two side spans each one-half of this, or 302½ ft. The width between stiffening trusses is 62.6 ft. (19.1 m.) c. to c., or 59.6 ft. in the clear, and the width of roadway 36.7 ft. throughout. The approaches, which are to be of reinforced-concrete construction, will be wider, 66.7 ft. (20.3 m.) between railings. The gradients of the approaches will be 1:38, and the gradients on the suspension bridge 1:40 on either side, joined at the middle by a parabolic curve extending 110 ft. each way from midspan, with versed sine of 16½ in.

The photographic illustrations show the bridge as it will appear when built.

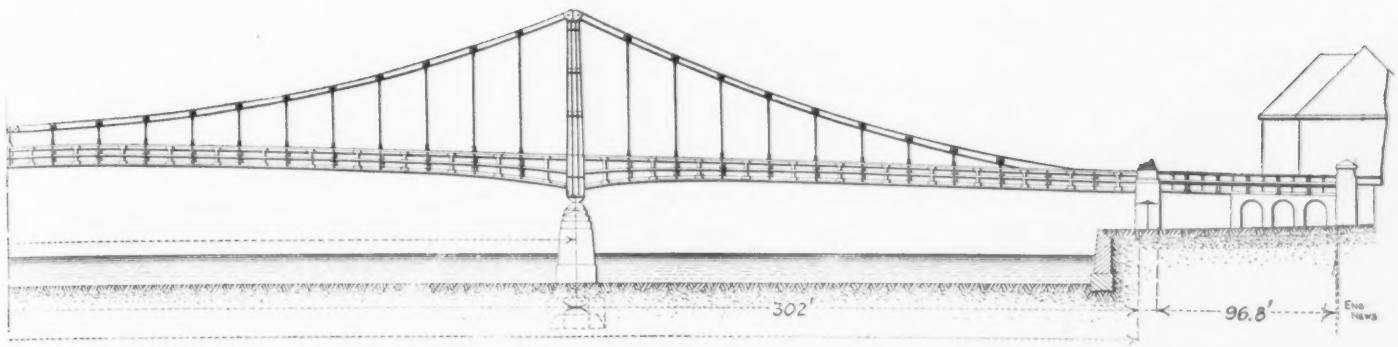
Inasmuch as esthetics played so important a part in the selection of the design it will be of interest to touch upon this point with a view to seeing how the component parts were thereby affected. In their original design the M. A. N. submitted alternative designs for the suspension chain made up as a riveted member, a cable, and an eye-bar chain; the latter mode of construction was adopted, for the following reason: Esthetically the suspension chain built up of eye-bars is superior to a built-up member in that it is easier for the eye to grasp its correct technical function, and possesses an advantage over the cable construction in that its mass enables it when viewed from the distance to be well recognized as being the most important member of the structure. The selection of round-iron suspension rods allows of unobstructed outlook on the Rhine. The natural subdivision of the stiffening girders into rectangular areas by the longitudinal and vertical splices eliminates all chance of monotonous perspective.

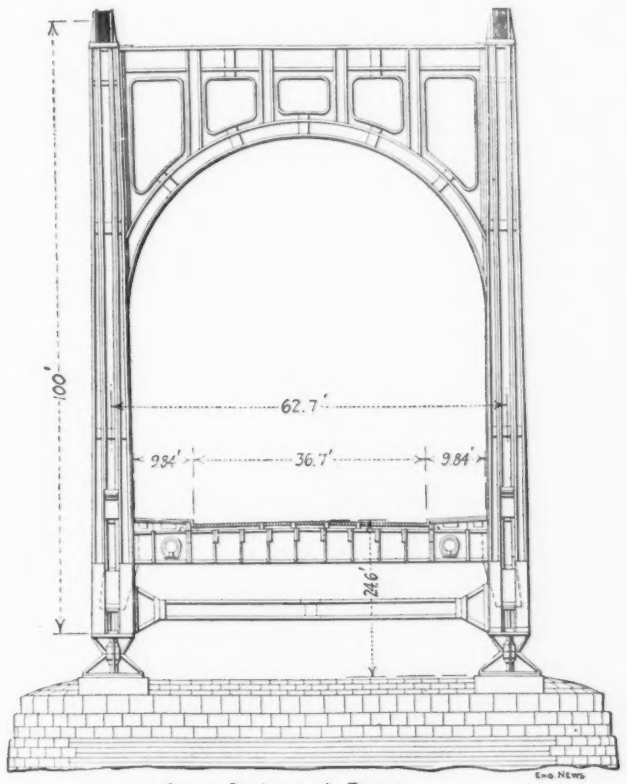
It was at first thought that the top flange-plates of this girder, which are 36 in. (90 cm.) wide, would work discordantly and prove disturbing to the outlook on the river. By building *a full-size wooden model two panels long,* the bridge company proved that no inconvenience could arise from this cause, and demonstrated at the same time the esthetic merits of their design.

USE OF NICKEL-STEEL

Nickel-steel is used for all the main structural parts of the bridge: stiffening girders, suspension chains, floor-beams.

Carbon steel is used for the towers, hangers, windbracing, stringers, and floor troughing.





Cross-Section at Tower

The total amounts of the different metals in the structure are, approximately:

	Tons
Nickel steel	6500
Carbon steel	2200
Cast steel	220

In view of this being the first large bridge to be built of nickel-steel in Europe it will be of interest to note the permissible working stresses decided upon. The steel contains 1.5% nickel and certain percentages of chrome which the rolling mills hold secret.

The permissible working stresses are:

	Kg. per sq. cm.	Lb. per sq.in.
(a) MILD STEEL		
(1) Road and footway construction	800	11,400
(Under steam-roller loading)	(1000)	(14,200)
(2) Windbracing	1000	14,200
(3) Rivet shear: For road and footways	650	9,200
For main girders and windbracing	900	12,800
(4) Rivet bearing: Twice the shear values		
(b) NICKEL-STEEL		
(1) Floorbeams	1200	17,000
(Under steam-roller loading)	(1650)	(23,400)
(2) Suspension chains: Vertical load only	1760	25,000
Vertical load, wind and temperature	2160	30,700
(3) Stiffening girder	1650	23,400

Stiffening Girder

The fixed bearing of the stiffening girder is on the west pier at point 12, the other three bearings being movable. The girder is arched upward for better appearance. It is of box section, or rather inverted U-section, with top flange-plate but open at the bottom to facilitate inspection and repair. For a comparatively small length, between points 1 and 3, the top flange-plates also are discontinued, so as to permit of the suspension chain being brought in between the webs. At the ends of the stiffening girders the suspension chains are connected to the girder, i.e., anchored, by bolts 24 in. (600 mm.) in diameter.

The web plates of the girder are $\frac{13}{16}$ in. (20 mm.) thick, and from 126 in. to 216 in. (3.20 to 5.50 m.) deep, which great depth necessitates their being spliced on the center line. Rigid internal diaphragms are provided at frequent intervals, and the stiffening girder is liberally proportioned to withstand crippling under the enormous compressive load of 4000 tons which the suspension chains induce. Erection splices are arranged in every second panel.

Suspension Chains

The chains are of nickel-steel. The consecutive panels of eye-bars* are connected together at panel-points by 12-in. (300-mm.) bolts (except near the ends, where larger pins are required because fewer and wider bars are used). The permissible bearing pressure is taken at 45,000 lb. per sq.in. (3170 kg. per sq.cm.), and for the weakest portion of the eye-bar the allowable stress is taken at 23,700 lb. per sq.in. (1670 kg./cm.^{2}) The eye-bars are strengthened by reinforcing plates at the eye.

The ordinate to the chain parabola in the middle span is 60.5 ft. (one-tenth the span); in the side spans 7.58 ft.

The number of bars in each of the two chains varies from 6 to 12; their thicknesses range from $\frac{7}{8}$ in. to 1 in. (22 to 25 mm.). From the tops of the towers down to the anchorage pins at the abutments the number of bars gradually decreases (so that the chain can be brought in between the webs of the stiffening girder), but the width of bar is increased so as to maintain the sectional area of the chain constant; the maximum width of bar, occurring at the anchorage pin, is 59 in. (1.5 m).

Towers

The design and proportions of the towers are shown by the illustrations. The tower posts are liberally stiffened with internal diaphragms, and have manholes for inspection and painting.

The maximum load per tower is 3600 tons, and in addition the towers are subjected to bending moments from wind pressure.

The stiffening girder passes through a slot in the base of the tower post (so as to be free to expand and contract), and rests on a roller-bearing inside the tower. Sufficient clearance is given between post and girder to permit of painting.

*Not eye-bars of the American type, but plates with parallel edges, and a hole bored near each end to take the pin.

The hangers are 5½ in. (140 mm.) in diameter. Each has a turnbuckle in the middle, for length adjustment during erection. They are connected to the chains and the stiffening girders by 5½-in. (140-mm.) pins, so that they are perfectly free to swivel. The arrangement shown in Fig. A will be modified by substituting steel castings for angles and plates as reinforcement of the hanger plates.

The bridge company originally planned to make every third hanger a built-up riveted member, in order to break the monotony of a long line of round-iron suspenders, and, in the view from a distance, to bring into better prominence the connections between roadway and chain. The municipal authorities were not in agreement with this idea, however, and in consequence all suspenders will be round rods.

At midspan a rigid member is used in place of a hanger rod, to give lateral support to the suspension chain against wind pressure

The bearings at the abutments are not only movable but are arranged to take up either downward pressure or uplift. The bottom roller, 12 in., takes the positive loads. Uplift is taken up by three rockers on top, acting against a shoe which is held down by four anchorage bars. The maximum uplift per girder is 440 tons; each anchorage bar is proportioned for 110 tons pull.

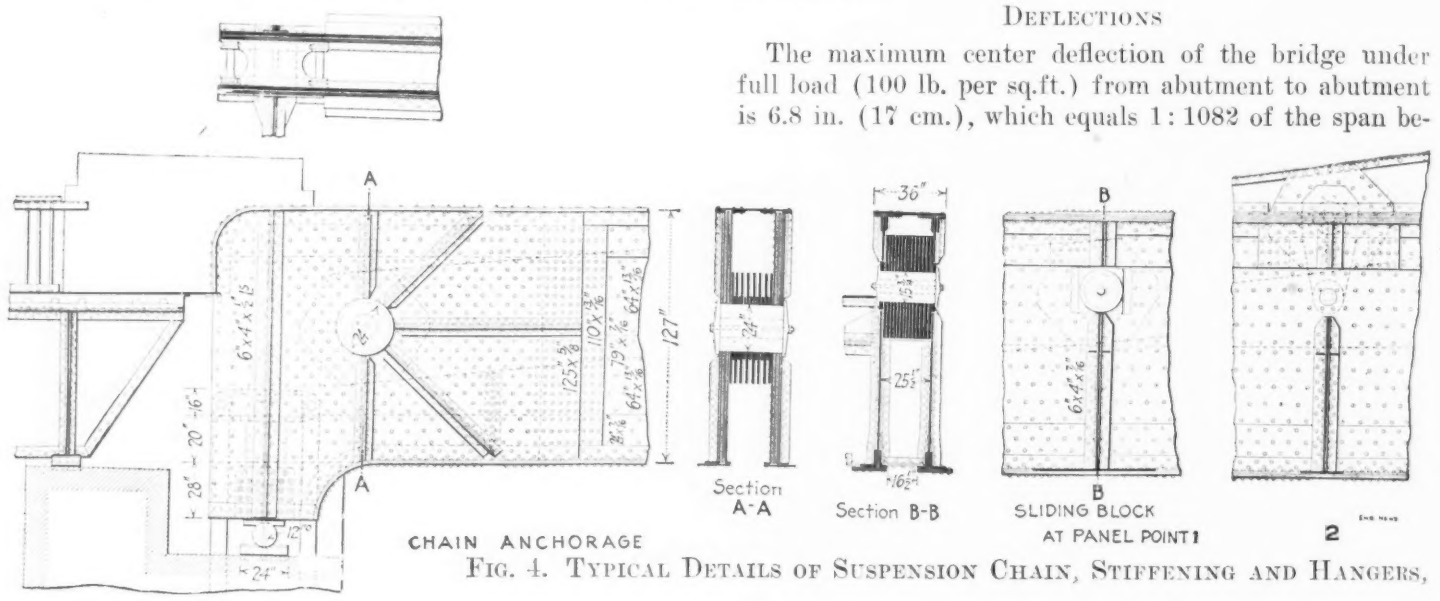


FIG. 4. TYPICAL DETAILS OF SUSPENSION CHAIN, STIFFENING AND HANGERS.

The bearings of the stiffening girders at the towers are built up of top and bottom castings machined to spherical shape. The contact surface has a diameter of 28 in. The top saddle casting is securely bolted to the tower post. Fig. A shows this bearing.

The windbracing is located under the floorbeams. The distribution of wind load is as follows: wind pressure on the hangers distributes equally between suspension chain and stiffening girder. Wind loads on the roadway are taken up by the lateral system. Wind pressure against the chain is transferred at five points, tower tops, abutments, and the rigid hanger frame at midspan.

The roadway is of wooden blocks on a concrete base, while the footway is of asphalt on concrete. In every fourth panel the roadway is divided by an expansion joint, so as to be less affected by the elastic deformation of the main system. The drainage water is carried by longitudinal gutters to the bridge supports and there discharged by downpipes.

An inspection wagon running on the bottom flanges of the stiffening girder is provided for inspection and repair purposes.

DEFLECTIONS

The maximum center deflection of the bridge under full load (100 lb. per sq.ft.) from abutment to abutment is 6.8 in. (17 cm.), which equals 1:1082 of the span between towers. With the middle span alone fully loaded, the deflection is 13½ in. (33.7 cm.), or 1:547 part of the span.

When the side spans alone are loaded the gradients on the bridge become steeper, changing from 1:40 to 1:36.2.

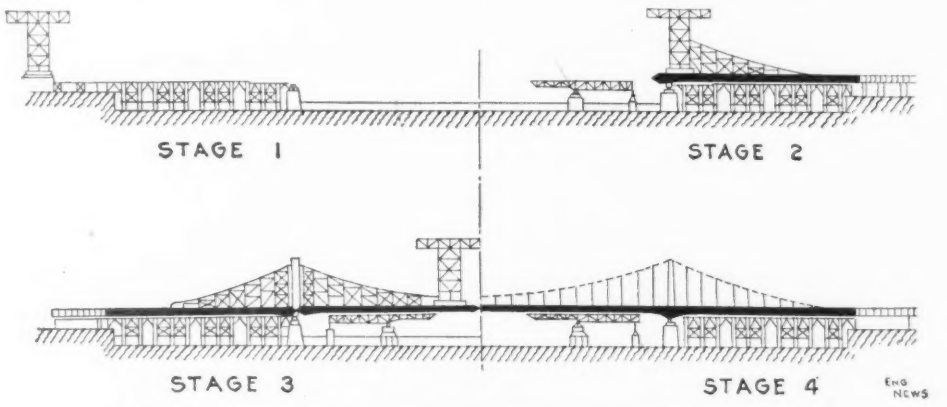


FIG. 5. FOUR STAGES IN THE ERECTION PROCEDURE AS PLANNED FOR THE COLOGNE BRIDGE

(Adjustment of the hangers to give zero moment in the stiffening girder at full dead-load is to be made by screwing up the turnbuckles in the hangers, after the falsework is removed, in such manner as to bring the chain pin-centers into the true equilibrium curve.)

Uniform temperature change has no effect on deflections; a difference of 18° F. (10° C.) between chain and stiffening girder changes the deflections by 2.8 in. (7 cm.).

As the bridge has no land anchorages, the pull in the suspension chain cannot be taken up until the stiffening girder is erected and ready to be put under compression. The erection of the stiffening girders and the chains will therefore proceed simultaneously, on special staging, and it will be so conducted that the stiffening girder is completed first.

Though the completed bridge is statically indetermin-

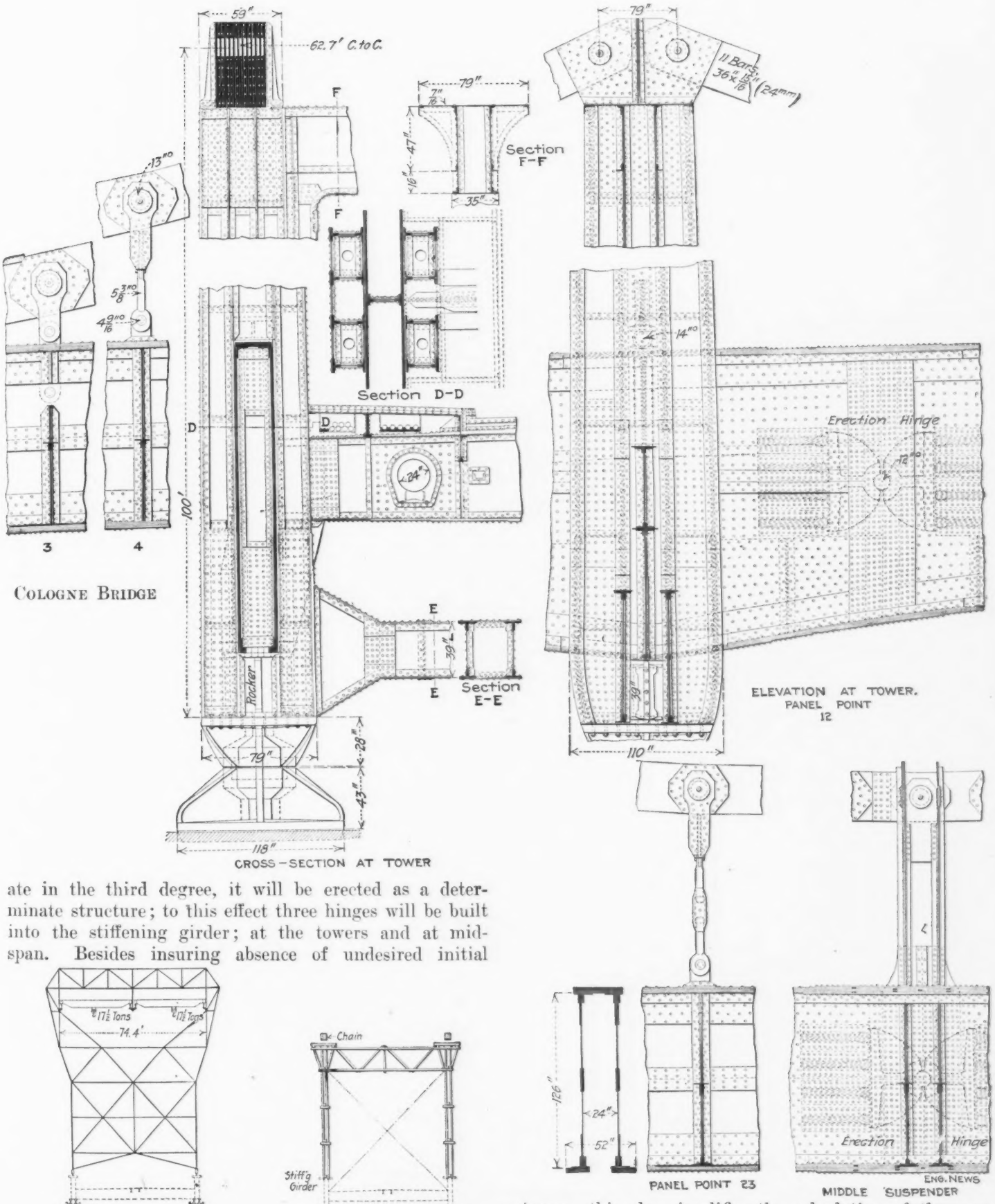


FIG. 6. TRAVELER AND FALSEWORK FOR CHAIN ERECTION, COLOGNE BRIDGE

COLOGNE BRIDGE

CROSS-SECTION AT TOWER

ate in the third degree, it will be erected as a determinate structure; to this effect three hinges will be built into the stiffening girder; at the towers and at mid-span. Besides insuring absence of undesired initial stresses, this also simplifies the calculation of the erection stresses and deflections.

When the stiffening girder is finished and the suspension chain connected thereto every third hanger will be coupled up. The staging carrying the chains will then be removed and the remaining hangers coupled up and adjusted by means of the turnbuckles to bring the pin points into their correct positions, after which the splices in the webs and flanges of the stiffening girder at the three hinge-points will be riveted up.

Precipitation and Runoff, Ishikari River, Japan, with Special Relation to Ice Conditions

By B. Okazaki*

Some years ago the author attempted to determine the ratio of stream flow to precipitation in the Ishikari River drainage area, Japan. For this purpose he made a long-continued series of gage observations and discharge determinations, particularly at the Tsuishikari gage section, and of precipitation records at 20 stations located in the drainage area above Tsuishikari. To his disappointment the author found that the available data showed the annual runoff to be in excess of the annual precipitation. The author thought that this anomaly might be due to (1) uncertainty, unavoidable to some extent, in the measurement of snowfall and (2) defects in the way of determining the discharge when ice prevails in the river, caused by applying the gage readings of this season to an open-water discharge curve. It seemed that the discharge under ice cover should be something different from that in open water for equivalent gage height, particularly when the ice forms very thick and abounds with slush and anchor ice.

To test the soundness of these assumptions the author, in February and March, 1908, and January, February and March, 1909, had his assistant, K. Sakamoto, measure the real discharge under ice cover with a current meter put into the stream under ice, through holes made at suitable distances apart in a cross-section. By opening the holes in the ice it was found, in a majority of cases, that the water running up through newly-made holes soon reaches to a level nearly flush with the upper surface of the ice cover and then rises no more. Thus it is seen that a cross-section of the running stream is diminished by the thickness of ice varying from point to point in the same cross-section. Besides the ice cover, it sometimes happens that a portion of the stream cross-section is choked up with slush and anchor ice as shown by Fig. 1, which represents the actual state of a cross-section of the Ishikari River at Fukagawa as measured in the winter of 1908. Irregularity of the ice condition of a stream is forcibly illustrated by the cross-sections of the same river at Tsuishikari in 1908 and 1909 (Figs. 2 and 3). For 1909 (Fig. 3) gagings are shown at the regular station and also at points 400 ft. upstream and 400 ft. downstream from the station. From these sections it seems that there can be no such relation between the gage height and the corresponding discharge under ice as exists in the case of open water.

A series of 35 observations, covering January, 1908, to March, 1909, made by the assistant already named, shows that the ratio of the mean velocity in the vertical to the corresponding mid-depth velocity varies from 79 to 93%, the average of all being 84%. At the Tsuishikari section of the Ishikari River the ratio varies between 85 and 87%, the average of all being 86%. The same observations also show that the discharge under ice cover is always less than that for the equivalent gage height in open water, the ratio varying from 21% to 53% for the year 1908 and from 12% to 61% for the year 1909. At the Tsuishikari section the said ratio is 53% for 1908 and 61% for 1909, varying from year to year. Table I gives similar and other data for a number of gaging stations on the Ishikari River and its tributaries.

Thus far there seems to be no definite relation between gage height and discharge, and it may be concluded that the observation of gage height under ice condition is not so important as in the case of open water; however, the gage heights under ice condition set the limit of maximum flow and tend to show any breaks in the continuity of the discharge. On that account, they must be observed throughout the whole season, though they do not serve an accurate basis for computations. Consequently careful direct measurement of winter discharge must be made, though it is not necessary to perform it every day, as the daily gage and climatic observation may well suffice to give information as to the discharges intermediate of the said actual measurements done at some such short intervals as ten days.

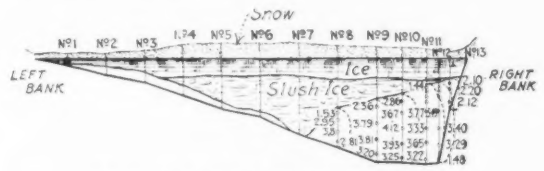


FIG. 1 - AT FUKAGAUA, MARCH 13, 1908

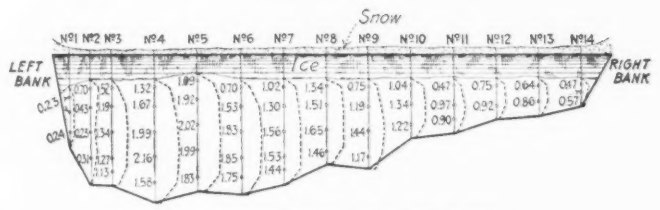


FIG. 2 - AT TSUISHIKARI, FEB. 25, 1908

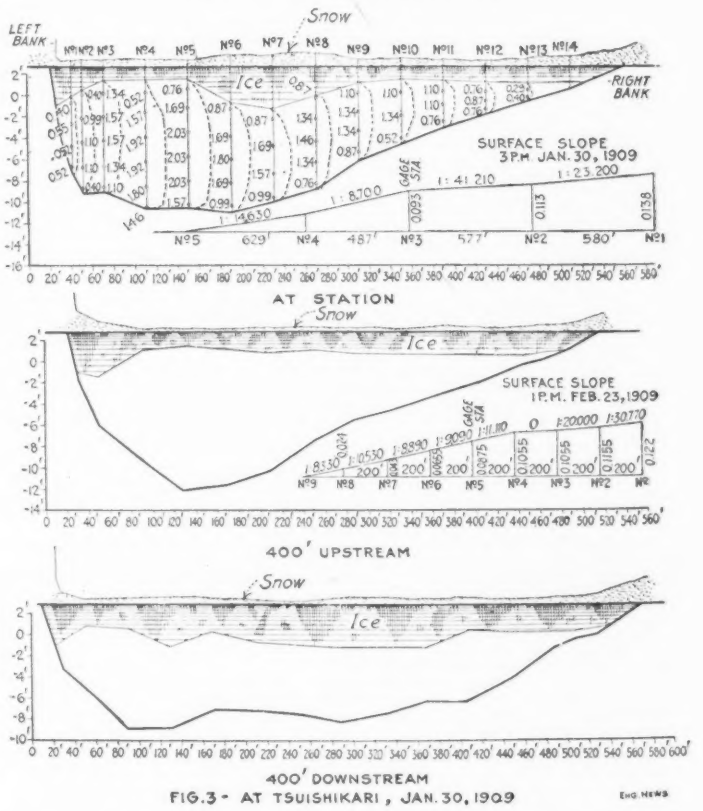


FIG. 3 - AT TSUISHIKARI, JAN. 30, 1909

FIGS. 1 TO 3. WINTER GAGINGS OF THE ISHIKARI RIVER, JAPAN, SHOWING ICE CONDITIONS AND SNOW ON ICE

(Vertical velocity curves are shown on some of the cross-sections.)

*Chief Engineer, Ishikari River Improvement Works, Sappora, Japan.

TABLE I. DISCHARGE MEASUREMENTS UNDER ICE CONDITION FOR ISHIKARI RIVER AND ITS TRIBUTARIES 1908—1909*

River	Gage station	Date	Mean deptns in ft. To water[1]	Ice[2]	Snow	Water	Net sectional area Sq.ft.	% of gross	Mean velocity[3] ft. per sec. for Gross area	Net area	Discharges, sec.ft. Actual	Per sq.mi.	% open water[4]
Ishikari	Barraguto	Feb. 15, '08	2.11	1.7	0.5	18.5	7421.3	63	0.38	0.61	4495.2	0.81	..
Ishikari	Barraguto	Feb. 16, '08	2.21	1.7	0.5	18.6	5192.0	44	0.22	0.50	2581.5	0.45	..
Isnikari	Barraguto	Feb. 17, '08	1.96	1.9	0.5	18.4	7605.0	64	0.42	0.65	4920.9	0.87	..
Ishikrai	Barraguro	Feb. 18, '08	1.61	2.1	0.5	18.1	7968.0	68	0.51	0.74	5921.1	1.06	..
Ishikari	Tsuishikari	Feb. 22, '08	3.66	2.6	0.5	9.5	3683.0	74	0.94	1.28	4723.7	0.87	..
Ishikari	Tsuishikari	Feb. 23, '08	3.82	2.6	0.5	9.6	3732.3	74	0.93	1.26	4718.8	0.87	..
Isnikari	Tsuishikari	Feb. 24, '08	3.80	2.8	0.5	9.6	3568.0	71	0.83	1.17	4180.8	0.77	..
Ishikari	Tsuishikari	Feb. 25, '08	3.66	2.8	0.5	9.5	3658.5	73	0.93	1.27	4639.9	0.86	..
Isnikari	Tsuishikari	Mar. 16, '08	3.45	2.7	0.6	9.3	3422.8	68	0.88	1.26	4336.2	0.81	..
Ishikari	Tsuishikari	Mar. 16, '08	3.48	2.7	0.6	9.3	3281.3	66	0.87	1.31	4329.9	0.81	..
		Mean	3.65	....	....	....	.....	..	....	Mean	4488.2	....	53
Ishikari	Tsuishikari	Jan. 27, '09	2.90	1.9	0.8	8.9	3687.0	78	0.95	1.22	4496.0	0.83	..
Ishikari	Tsuisnikari	Jan. 28, '09	2.87	2.0	0.8	8.9	3647.0	77	0.92	1.19	4357.2	0.81	..
Isnikari	Tsuishikari	Jan. 30, '09	2.76	1.9	0.8	8.6	3535.0	77	0.94	1.22	4297.8	0.79	..
Ishikari	Tsuishikari	Feb. 5, '09	3.06	2.0	1.0	8.6	3478.0	77	0.92	1.20	4182.4	0.78	..
Isnikari	Tsuishikari	Feb. 23, '09	2.60	2.5	0.4	8.9	3393.0	72	0.87	1.21	4115.2	0.76	..
Ishikari	Tsuishikari	Feb. 23, '09	2.73	2.4	0.4	9.1	3512.5	73	0.74	1.02	3579.2	0.66	..
Ishikari	Tsuishikari	Feb. 24, '09	2.63	2.4	0.4	9.0	3471.0	73	0.74	1.02	3523.9	0.65	..
Ishikari	Tsuisnikari	Mar. 23, '09	2.84	2.4	0.7	8.7	3348.0	72	0.96	1.33	4436.6	0.82	..
		Mean	2.80	....	....	....	.....	..	....	Mean	4123.5	....	61
Ishikari	Tsukigata	Feb. 28, '08	25.35	3.9	1.2	9.0	2586.7	66	0.69	1.04	2695.5	0.74	..
Ishikari	Tsukigata	Feb. 29, '08	25.36	3.6	1.1	9.0	2546.1	65	0.67	1.02	2606.8	0.71	..
Ishikari	Tsukigata	Mar. 1, '08	25.36	3.6	1.1	9.0	2604.0	67	0.69	1.08	2807.0	0.77	..
Isnikari	Tsukigata	Mar. 2, '08	25.30	3.6	1.1	8.9	2521.9	65	0.71	1.08	2729.0	0.74	..
		Mean	25.34	....	....	....	.....	..	....	Mean	2709.6	....	26
Ishikari	Takikawa	Mar. 3, '08	75.31	2.1	0.7	5.6	1587.0	70	0.86	1.22	1942.3	0.86	..
Ishikari	Takikawa	Mar. 4, '08	75.32	2.1	0.7	5.6	1566.9	69	0.83	1.21	1889.1	0.84	..
Ishikari	Takikawa	Mar. 5, '08	75.25	2.1	0.7	5.6	1539.9	68	0.81	1.20	1842.0	0.82	..
		Mean	75.29	....	....	....	.....	..	....	Mean	1891.1	....	37
Isnikari	Takikawa	Feb. 1, '09	74.79	1.3	0.9	4.8	1423.9	72	0.77	1.06	1506.8	0.67	..
Isnikari	Takikawa	Feb. 3, '09	74.88	1.4	0.9	4.9	1455.5	72	0.84	1.17	1702.3	0.75	..
Ishikari	Takikawa	Feb. 18, '09	75.10	1.8	0.3	5.1	1344.0	64	0.75	1.16	1560.5	0.69	..
Ishikari	Takikawa	Mar. 19, '09	75.10	2.1	1.1	5.3	1290.0	60	0.66	1.11	1433.2	0.64	..
		Mean	75.00	....	....	....	.....	..	....	Mean	1550.7	....	34
Ishikari	Fukagawa	Mar. 11, '08	158.58	1.8	1.1	5.0	480.3	47	1.22	2.60	1248.2	0.89	..
Ishikari	Fukagawa	Mar. 12, '08	158.56	1.8	1.1	5.0	439.2	43	1.09	2.54	1116.3	0.79	..
Ishikari	Fukagawa	Mar. 13, '08	158.68	1.8	1.1	5.0	448.4	44	1.17	2.67	1195.5	0.86	..
		Mean	158.61	....	....	....	.....	..	....	Mean	1186.7	....	52
Toyohira	Tsuishikari	Feb. 23, '08	5.05	2.1	0.5	4.5	273.7	55	0.53	0.96	262.3	0.82	..
Toyohira	Tsuishikari	Feb. 24, '08	4.95	2.1	0.5	4.4	263.2	54	0.52	0.94	249.6	0.77	..
Toyohari	Tsuishikari	Feb. 25, '08	4.95	1.9	0.5	4.4	271.6	56	0.55	0.98	266.4	0.84	..
Toyohira	Tsuishikari	Mar. 15, '08	....	2.8	0.5	4.6	274.7	53	0.54	1.01	279.4	0.87	..
Toyohari	Tsuisnikari	Jan. 28, '09	....	1.4	0.9	3.5	224.0	58	0.48	0.82	184.7	0.58	..
Toyohira	Tsuishikari	Jan. 29, '09	....	1.5	0.9	3.5	212.4	55	0.55	0.99	210.6	0.66	..
Toyohira	Tsuisnikari	Feb. 5, '09	....	1.7	1.0	3.5	194.0	51	0.38	0.75	144.9	0.45	..
Toyohari	Tsuishikari	Feb. 22, '09	....	1.6	0.4	3.5	210.2	54	0.44	0.80	169.0	0.53	..
Toyohira	Tsuisnikari	Mar. 23, '09	....	1.7	0.3	3.7	213.0	53	0.52	0.99	209.8	0.66	..
Toyohira	Adsuma	Feb. 10, '09	....	2.3	0.8	5.2	290.5	54	0.27	0.50	143.9	0.57	..
Ebetsu	Ebetsu	Feb. 25, '08	6.22	2.0	0.5	5.8	682.1	63	0.76	1.19	815.0	0.87	..
Ebetsu	Ebetsu	Feb. 26, '08	6.16	2.0	0.5	5.6	678.2	64	0.85	1.33	912.2	0.97	..
Ebetsu	Ebetsu	Mar. 15, '08	6.33	2.0	0.5	5.8	651.4	57	0.98	1.72	1089.2	1.18	..
Ebetsu	Ebetsu	Jan. 29, '09	5.64	1.3	0.7	5.5	811.1	77	0.91	1.19	965.0	1.03	..
Ebetsu	Ebetsu	Jan. 31, '09	5.38	1.2	0.7	5.2	769.5	77	0.70	0.92	705.0	0.76	..
Ebetsu	Ebetsu	Feb. 4, '09	5.53	1.4	0.8	5.3	772.0	75	0.85	1.13	880.1	0.94	..
Ebetsu	Ebetsu	Feb. 22, '09	5.52	1.5	0.3	5.3	732.3	71	0.73	1.02	747.8	0.80	..
Yubari	Kuttari	Feb. 20, '08	48.22	2.7	1.0	5.0	302.5	53	0.26	0.50	150.4	0.34	12
Horomui	Horomui	Feb. 26, '08	7.71	3.0	0.5	10.3	664.7	71	0.14	0.20	132.2	0.57	..
Bibai	Minenobu-Tsukigata road	Feb. 27, '08	2.45	1.5	0.3	3.4	57.0	54	0.39	0.72	41.3	0.60	..
Shibetsu	Ishikari	Mar. 1, '08	25.36	....	....	0.7	15.2	100	1.73	1.73	26.3	1.19	..
Soracni	Railway	Mar. 3, '08	79.09	2.1	0.9	5.7	331.6	43	0.91	2.10	697.4	0.66	..
Soracni	Railway	Mar. 5, '08	79.05	2.1	0.9	5.7	294.8	38	0.82	2.12	634.5	0.60	..
		Mean	79.07	....	....	....	.....	..	....	Mean	666.0	....	21
Sorachi	Railway	Feb. 2, '09	78.84	2.2	0.8	3.7	295.2	40	0.89	2.23	658.5	0.62	..
Sorachi	Railway	Feb. 3, '09	78.85	2.1	0.8	3.7	309.2	42	0.91	2.17	672.4	0.64	..
Sorachi	Railway	Feb. 19, '09	79.31	5.5	0.6	7.9	347.3	30	0.52	1.71	594.8	0.56	..
Sorachi	Railway	Mar. 19, '09	79.19	4.7	1.3	7.5	414.8	38	0.46	1.22	505.7	0.48	..
Uriu	Kofudi	Mar. 6, '08	114.74	2.9	1.7	7.0	713.6	60	0.31	0.53	380.6	0.59	..
Uriu	Kofudi	Mar. 7, '08	114.77	2.9	1.7	7.0	718.0	60	0.31	0.52	375.3	0.57	..
		Mean	114.76	....	....	....	.....	..	....	Mean	378.0	....	54

* Nine columns of the original table have been omitted for lack of space, but the data omitted may be derived from that here given, except weather (which did not include temperature) and maximum and minimum ice depths.

[1]From ice surface to water surface after water surface came to rest in case water rose in hole cut in ice. [2]The general range of ice depths was from 5 to 2 ft. for the maximum, with an extreme of 7 ft., and from 3 to say 0.5 ft. for the minimum, with a number of cases of no ice. [3]From 13 to 2 vertical velocity curves were taken. The ratio of mean to mid depth velocities ranged from 93 to 79%. [4]Per cent. which actual discharge was of discharge computed by open-water rating curve.

The complete discharge diagram for winter must be prepared by plotting the days as abscissas and the results of actual discharge measurements as one of the ordinates, with the temperature, the gage heights and the discharges for the equivalent gage heights in open water, as the other ordinates. The results of the said actual discharge measurements plotted may suffice to form a fairly accurate curve for winter discharge, the intermediate points being plotted by the aid of the said temperature, gage heights and open-water discharges. The degree of accuracy obtained will depend upon the number of actual discharge measurements and the stability of the weather.

From the results obtained by our actual discharge measurements for two winters, commencing with January, 1908, we were able to find out the annual discharge and hence its relation to the annual rainfall for the two years from October, 1907, to September, 1909, inclusive. A general resumé of the results obtained from our climatic observation and hydrometric measurement is given by Table II. The data given lead to the conclusion that in one year the discharge is 98.5% and

TABLE II. COMPARATIVE TABLE OF RAILFALL AND DISCHARGE, ISHIKARI RIVER, JAPAN

(Gauge section at Tsuishikari; drainage area, 5,321 sq.miles; rain gauges set at 20 stations within the drainage area. See Table I. for some details).

	From Oct. 1906 to Sept. 1908 inclusive.	From Oct. 1908 to Sept. 1909 inclusive.
Max. discharge, cu.ft. per sec	100,020	113,720
Mean discharge, cu.ft. per sec	16,020	16,250
Min. discharge, cu.ft. per sec	3,970	3,630
Total discharge, cu.ft	544,227,694,400	512,491,968,000
Total discharge equivalent in depth, M.M.	1,024	1,021
Total precipitation, M.M	1,039	1,099
Per cent. discharge of precipitation	98.5	97.9
Assumed per cent. discharge under ice cover is of that computed for the equivalent gage heights in open water, from the results of occasional actual discharge measurements in ice season	53	61

in the other 97.9% of the corresponding rainfall. The percentages thus obtained seem to be too high and it is probable that there may be uncertainty in the measure-

ment of precipitation, particularly of snowfall. It may be added that 11.4% of the total drainage area is cultivated and the remaining portion is mostly wood or grass land.

In case of the record flood of July, 1904, we were able to determine the ratio of runoff to the corresponding rainfall for the Ishikari River and its tributaries. The duration of the flood is assumed to have been the time from the rising of the stage above the mean to its falling back to the mean. At Tsuishikari the ratio of runoff to rainfall was found to be 69% for the flood duration of 288 hours. A part of the remaining 31% probably feeds the discharge for the following mean and lower stages.

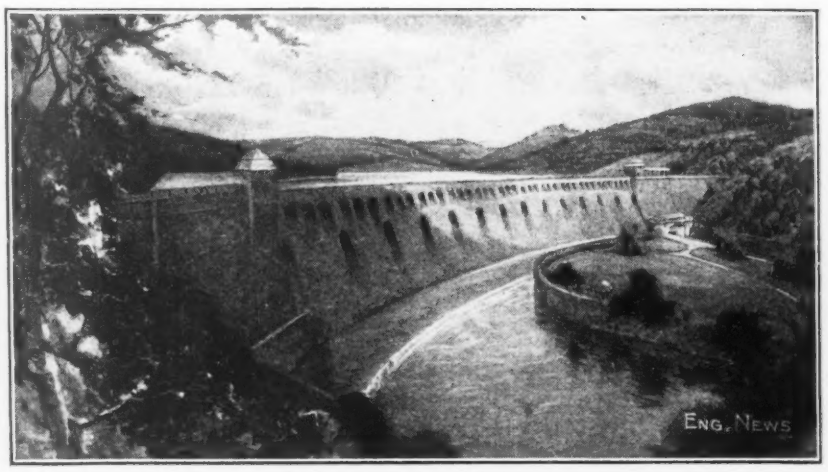


FIG. 1. THE WALDECK STORAGE DAM, GERMANY
(From a sketch by Karl Oenike, Berlin.)

The Waldeck Storage Dam, Germany

BY ROBERT GRIMSHAW*

In 1911 there was put under construction near Waldeck, in the German principality of the same name, a masonry dam about 160 ft. high. The dam will store water on the River Eder for the threefold purpose of (1) raising the low-water level of the River Weser for navigation in that stream and to feed the Rhine-Ems Canal; (2) flood protection, and (3) developing power. The project is a part of a great system of hydraulic improvements for which the Prussian Government appropriated M500,000,000 (nearly $125,000,000) in 1905.

The Waldeck Dam will form a reservoir having a maximum water depth of 138 ft.; a storage capacity of 202,400,000 cu.m., or some 53.5 billion U. S. gal.; a length of 27 km., or 16.78 miles, and an area of 1170 hectares, or 2925 acres. The drainage area above the dam is 542 sq. miles, of which area 40% is wooded. The highest point in the drainage area is 2722 ft. above sea level and the "sole" of the dam will be 666 ft. above the zero point on the Amsterdam tide post. The average yearly rainfall for the drainage area is 33 in. The average river flow at Hermfurt (not far from the Waldeck Dam) for the years 1905-10 was 18.8 cu.m., the winter flow having been 29.6 and the summer flow 8.2 cu.m. The range of flow is from 900 to 1 cu.m., and the greatest summer flow 250 cu.m.

With 10% of the storage capacity held as an emergency reserve, the new reservoir will prevent the flow of the River Eder from ever falling below 6 cu.m. (1558 U. S. gal.) per sec. The maximum flow that will be permitted will be 250 cu. m. per second (the same as the highest summer flow), which can do no damage.

Of the 2925 acres comprising the reservoir site, 2325 are farm land and 600 acres in forest. A number of small villages and many farms will be flooded by the reservoir and 150 families will be compelled to find new homes.

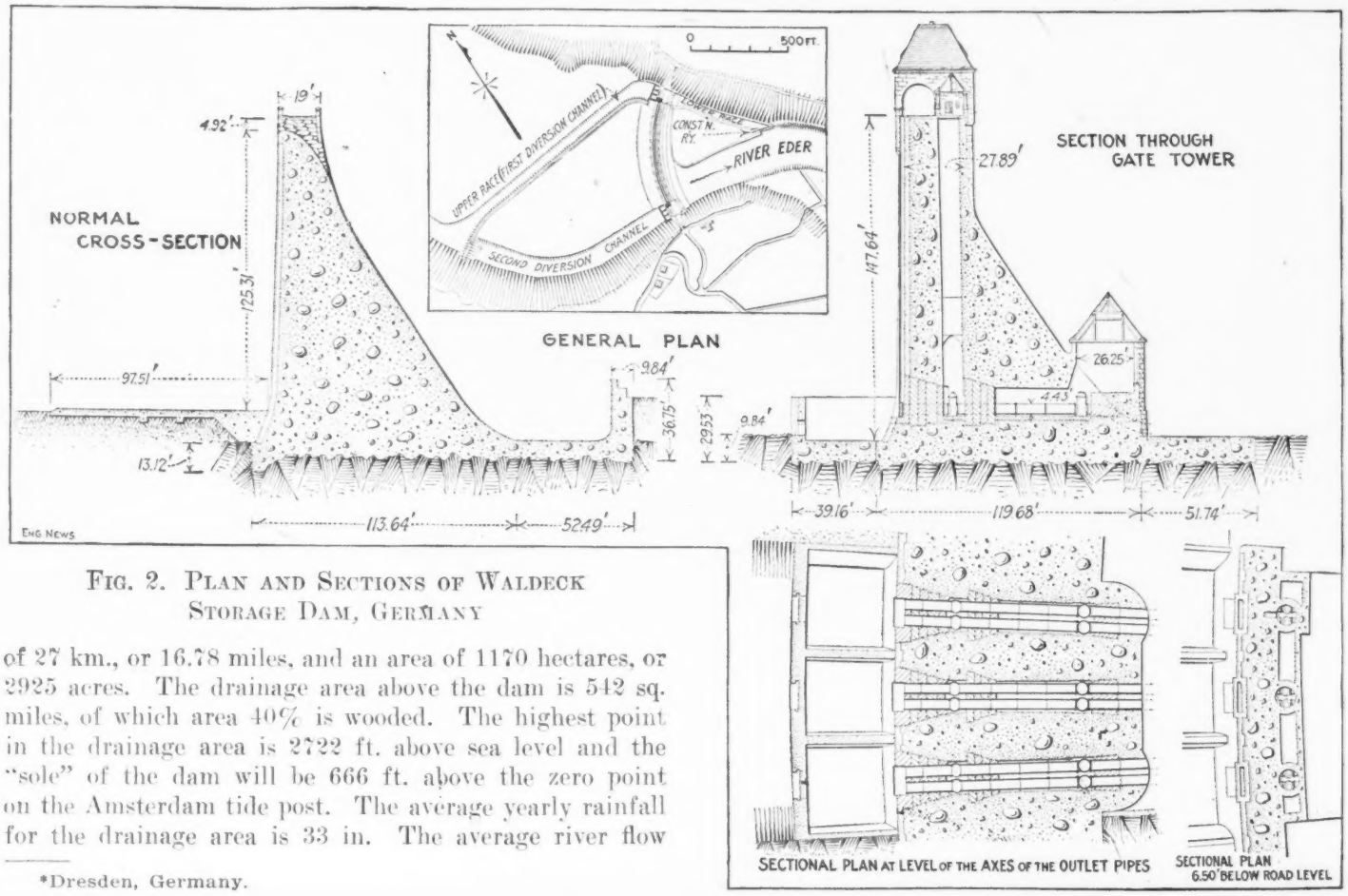


FIG. 2. PLAN AND SECTIONS OF WALDECK STORAGE DAM, GERMANY

*Dresden, Germany.

The entire project will cost M.19,750,000 ($4,902,380), of which M.9,000,000 ($2,142,850) is for land, M.7,900,000 ($1,880,950) for the dam, and M.2,850,000 ($678,572) for roads, etc.

Fig. 1, reproduced from a sketch, shows the dam as it will appear when completed. The line drawings combined in Fig. 2 show the general design and dimensions of the structure. Figs. 3, 4 and 5 are reproduced from photographs showing the dam at different stages of its construction.

The stratum on which the dam rests is firm and water-tight. The dam is built of grauwack (graywacke or fissile shale), of which there is plenty in the neighborhood, laid in mortar [cyclopean masonry].

The greatest pressure within the dam is 19.3 kg. per sq.cm. (278 lb. per sq.in.), measured in the direction of the tangent to the outline of the cross-section. The compressive strength of graywacke is about 1500 kg. per sq. cm. (21,334 lb. per sq. in.), that is, about 80 times the greatest pressure thereon. The specific gravity of the masonry is taken as 2.3; and the water pressure is not considered.

On the stream side the dam will have a water-tight cement coating, which will be protected from mechanical injury by a 30-in. wall of rough quarry-stone.

Fig. 3. Cleaning Out the River Bed, Apr. 24, 1911

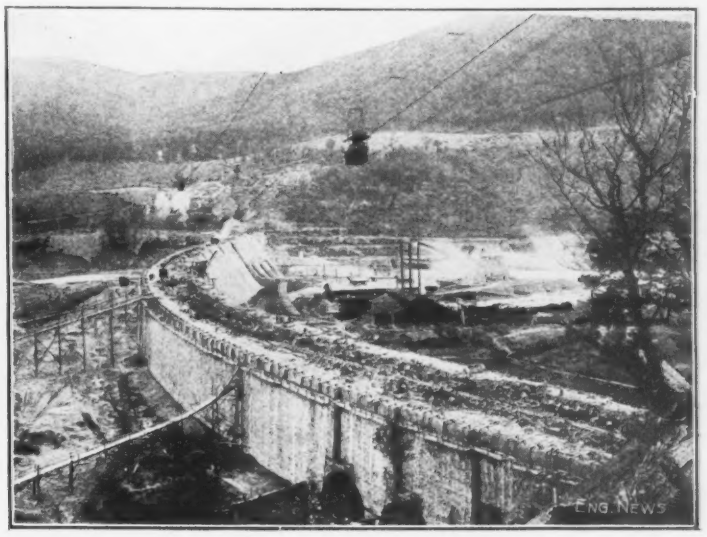


Fig. 5. Masonry under Construction, Sept. 9, 1912

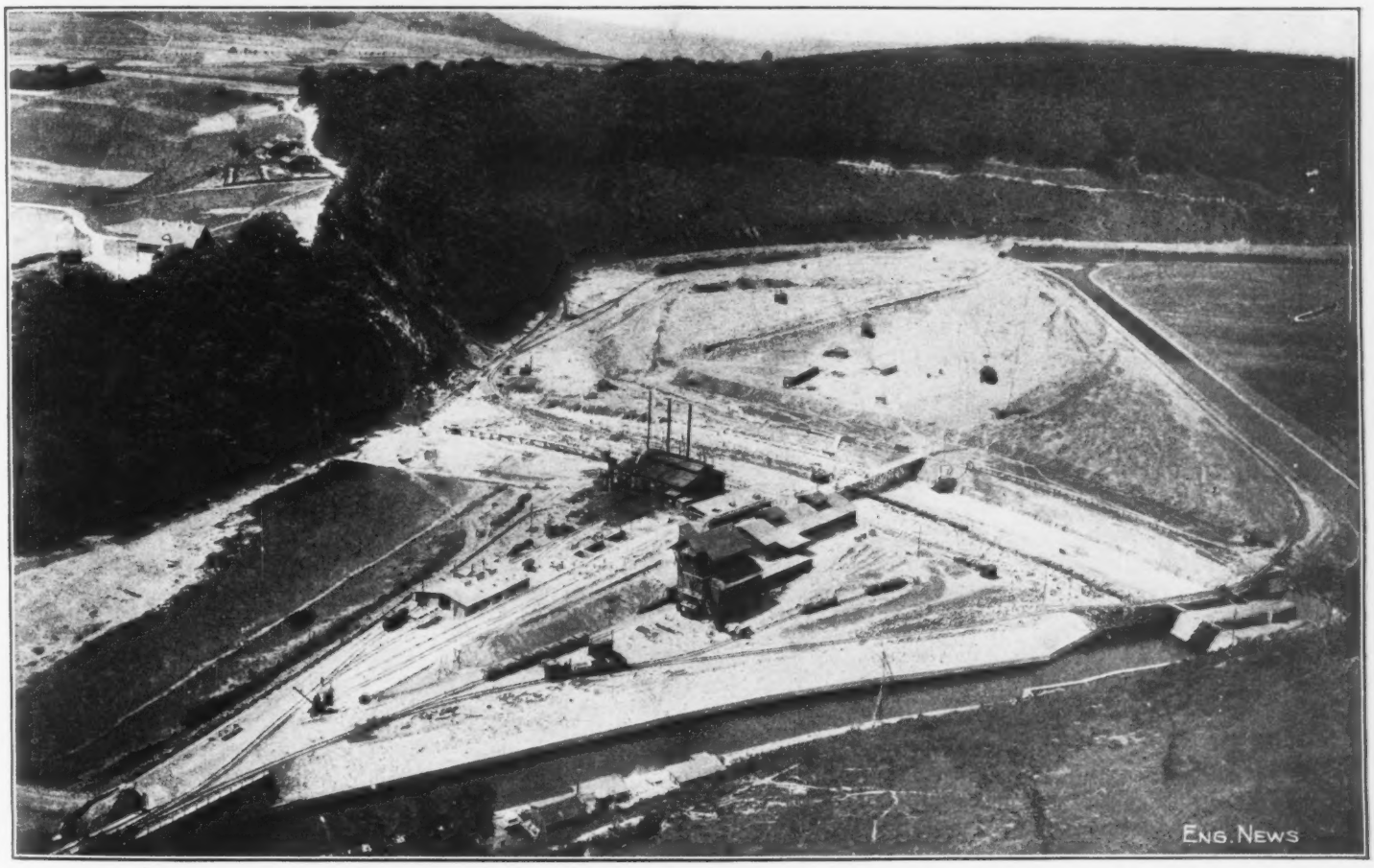


Fig. 4. General View of Damsite, First Diversion Canal and Tailrace, June 22, 1911

Figs. 3 to 5. Constructing the Waldeck Dam, Germany

To guard against possible seepage there are provided "bleeders." The ground plan of the dam has a radius of 305 meters or 1,000 ft., the arch being used to allow for alterations in length from changes in temperature.

There will be necessary about 300,000 cu.m. (79,251,600 cu.ft.) of masonry. About two-thirds of this will be stone, one-third mortar consisting of 1 volume of lime, 1½ of trass (volcanic slag) and 2 of sand (lime-trass mixtures are in wide use in Germany for hydraulic construction).

About 6 m. (19.68 ft.) above the sole of the dam there will be 12 iron pipes, 6 at each bank; laid pairwise in the canal, 4 m. (13.12 ft.) wide and 3.75 m. (12.30 ft.) high. These serve to feed the turbines; the penstocks of the latter on the left bank are 1.50 m. (4.92 ft.) internal diameter; those on the right bank, solely for use in case of high water, are only 1.35 m. (4.43 ft.). Each overflow pipe is supplied with the necessary cut-off valves, in pairs one behind the other for safety; in case of emergency each pipe can be closed by an iron plate held in place by the pressure of the water. That part of the masonry containing these overflow pipes is thicker than the rest.

Although the entire scheme is based on a maximum flow of 250 cu.m. (66,043 gal.) per sec., the central portion of the dam is supplied with an overflow for high water, 152.5 m. (500 ft.) long, and permitting a depth of overflow of 1.45 m. (4.76 ft.). The overflow would run down the lower face of the dam and fall into a bed of water 6 m. (19.68 ft.) deep.

Besides this high-water overflow, there are also 14 circular emergency openings, each 2.55 m. (8.36 ft.) in diameter, located 14.4 m. (47.2 ft.) below the crest of the dam. These are normally kept closed. Their cross-section is sufficient to pass the entire maximum flow as soon as the level reaches within 10 m. (32.8 ft.) of the crest of the dam. The most important outlets will be built after the dam is finished; the canals which are to contain the pipes will remain open at first, to let the water of the Eder flow away. To prevent damming back these are at first 3.5 m. (11.48 ft.) deeper than they will be finally.

The entire foundation trench for the dam, covering about 1.25 hectares (3⅛ acres) had to be excavated 3 to 4 m. (9.84 to 13.12 ft.). To divert the water of the Eder around this area, diversion channels were built. First the portion of the dam on the left slope and as far as possible from the right slope, where the Eder flows, was constructed, and in this the three conduits for the underground flows were built. Then the Eder was turned into these and the old bed dammed; so that the ditch could be dredged out.

The rock at the dam site was blasted away until a thoroughly firm unweathered stratum was reached. About 200,000 cu.m. (7,062,800 cu.ft.) of loose soil and rock were excavated, and about 10,000 blast-holes bored by air-drills. A total of 24 tons of Astralit were used for blasting.

About 250 cu.m. (8829 cu.ft.) of mortar were made per day. Three locomobiles, totaling 500 hp., were used to drive the mixers, etc. About 200 masons were engaged and put up 700 cu.m. (24,720 cu.ft.) of masonry per day. Besides, 200 men washed and brushed the stones; about 300 worked in the quarries; in all there were about 900 at work.

The Private Irrigation Project as an Investment

By Thomas Berry*

Under the controlling influence of the laws of most of the Western States highly profitable revenue from the actual conveyance of water from the source of supply to the lands of the various and numerous consumers has not been the basis of the anticipated profits which have influenced the banker to finance irrigation undertakings. In the sense herein assumed, the private irrigation project is one in which the chief attraction has been a more or less large body of land, ostensibly acquired at a nominal price, and which it is hoped to resell at a handsome advance over the combined original and reclamation costs.

To the investor probably no line of established investment has so many unpleasant memories as that of irrigation, while to the promoter and the broker it has been a source of varying recompense, depending on their moderate or immoderate methods and desires. The satisfactory and lasting reward has come to the genuine farmer who has loyally accepted the trying experiences of successfully transforming the desert—to him the results have been comparatively and highly profitable. Alone, the private project has a less hopeful outlook than if the field as a whole were under review.

There can be no doubt in the minds of those who have been long and closely associated with the development and operation of irrigation properties that there is sound reason for the general unfavorable attitude existing amongst financiers toward such investment. That this should be so, and that no remedy has been evolved and applied, cannot surely be evidence that the business of irrigation, unlike other legitimate undertakings, has not the inherent qualities necessary to all round success. The energetic farmer with a knowledge of agricultural principles flourishes and makes money under irrigation to a degree unknown in similar pursuits in the humid states. Between the first cost of the land plus the cost of reclamation, and the results of the successful farmer there is usually a wide margin of capitalized land value in which the estimated profit of the undertaking exists. Experience has demonstrated, however, that this margin too often passes in course of time from a potential profit-producing asset to one whose worth can be reckoned with only in estimating the loss in the investment.

With extensive highly attractive land areas available, the tendency has been toward over-estimation of the possibilities of the water-supply and, as a consequence, over-development, in which canals have sometimes been constructed and extended to command areas impossible of satisfactory reclamation. The charges for the cost of water rights and administration were approximately arrived at by the process of dividing the estimated costs in each case by the estimated area to be served, and on this foundation were esfablished for all time upon the issuance of an agreement or water deed. It was usually necessary to give definite values to these, as between the company and the prospective homemaker, before canal construction commenced, it being desirable for financial

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reasons that agreements for the purchase of as many water rights as possible, be a preliminary to promotion, showing thereby an encouraging nucleus of land settlement. In cases where there was a material overestimation, it followed, in the resulting adjustment of the water-supply to the reduced land area, that the actual unit costs of development and administration were greatly increased, which, with the aggregate estimates of construction often much below the actual cost, naturally meant a disadvantgeous remodelling of the profit plan of the company.

There are projects both of undoubted and doubtful value in a physical sense that have had to commence operations under a severe financial handicap in that only a deplorably small proportion of the face value of the irrigation bond has gone into the actual development of the property. In such cases it must appear that as between the investment side of the project on the one hand, and the ultimate agricultural outcome on the other, the financial manipulators have not been true to their trust, and that they have shown very doubtful generosity toward the welfare of the prospective homemaker.

In a broad sense, agriculture in itself is not speculative. It is a stable and profitable industry in which the workers do not accumulate abnormal wealth overnight, and when it has to start on its transforming journey under an unduly heavy financial burden, in other words, when its stock is deeply watered, naturally its satisfactory progress is made doubtful.

The welfare of some properties has been more or less seriously jeopardized by due consideration not having been given to the selection and classification of the lands to be served, topographically, and with reference to the effect of the character of the soil on the agricultural future.

In the early days although land with water sold at comparatively low prices the market and transportation facilities were in many cases unfavorable, and as a result the settler was often rich in the abundance of his crop, but poor in cash. Further, the farm unit was very often too large to be efficiently handled by the farmer of small means, which resulted in the crop product per acre being low, and the unit cost of production high.

With the advance in irrigation-engineering knowledge, and the accumulation of hydrographic data pertaining to most of the Western streams of importance, irrigation development could not continue to suffer from the lack of experience which characterized many of the earlier enterprises, and today, from an engineering point of view, there are reasonable grounds for the assertion that the worth of a project can be fairly established as a preliminary to construction. But irrespective of these the welfare and outcome of the legitimate undertaking of today, soundly financed and intelligently and honestly managed, are dependent, as they were in the past, not so much on the physical worth of the property as upon the supply of homemakers.

While many conditions have changed, the essentials to the success of the present-day irrigation project are not different from those of the past, and may be enumerated as follows:

(1) A compact body of land with good soil and drainage conditions, in a locality climatically and geographically favorable, and to which satisfactory transportation and market facilities exist.

(2) A safe water-supply.

(3) Low development and operating costs.

(4) Experienced management.

(5) Rapid colonization by energetic farmers with moderate means.

(6) Sound financiering.

Innumerable uncertainties enter into the calculations upon which the success or failure of a project is estimated. The source of revenue, the land, is in a sense the only unchanging element. Its area can be closely estimated, and the quality of the soil and its agricultural value in the light of existing market and transportation facilities ascertained.

The volume of the stream which supplies the water for irrigation may change from day to day, week to week, month to month, and year to year.

In regard to development cost, where such is apparently low, it is to be inferred that the sale price of the land should be relatively affected. In practice it is doubtful if it is so in all cases. Where a company is satisfied with a reasonable profit and maintains the market value of the land accordingly, other conditions being satisfactory, it must be said that the chief requisites to rapid colonization exist. It may be here asked, is the reasonable margin of profit to the farmer being maintained? If not, it would seem to be very doubtful if the high and increasing land values of today can be maintained. From the investor's point of view it is difficult to say what is a safe maximum unit cost for development. The locality and climatic conditions, the crops that can be raised, and the market, besides other factors, will govern in this respect, but for a general farming proposition of large area $50 per acre is probably a high figure. It is certainly high in the face of past experience in which dependence has been placed alone upon the settler to provide administrative revenue.

The very nature of an irrigation property, wrapped up as it is with agriculture, is synonymous with economy. The scope for financial recuperation does not exist as in some forms of investment. There are not years in which the revenue soars above normal, nor under existing conditions is there a possibility of such desirable elasticity. The management must be governed accordingly, and calls for a combination of a degree of frugality unknown in many other lines of work, with experience and business prudence.

Profitable returns to the investor rest upon the success of the farmer. He is truly the link between the soil and the capitalist, so that where means to the latter end—conditions or possibilities for a favorable agricultural outcome—do not exist, the situation can only be described as hopeless. Assuming that land, water, markets, transportation, management and finance are satisfactory, then the one important factor is rapid colonization. If the farmer with energy and stamina, and a moderate amount of capital can be brought upon the lands in numbers sufficient to carry the greater portion of the burden of administration charges, putting these where they rightfully belong, in the first two or three years of operation, and so that at the end of say five or six years the bulk of the land has been transferred, liberal success to the company would be assured, and there could be little chance of its financial plan being unduly stressed. But these are the desired conditions, as they might be, while experience has harshly demonstrated

that most legitimate projects, well and honestly conducted, have suffered, and it is perhaps safe to say that the majority have been in financial trouble, while many have reached the stage of distress or failure, as a result of the protracted delay in making the soil produce. No matter where or how favorable the opportunity presented to the farmer, as viewed by the promoter, quick enough movement toward the irrigated farm is seldom experienced. The area of unimproved irrigated land has always been in excess of the demand, and today this condition is more exaggerated than ever before.

Failure to attain rapid and satisfactory colonization means that the larger portion of the plant, representing an outlay of from $10 to $50 or more per acre, and the land, are in a business sense practically dormant, experience indicating that it takes 10, 15, 20 years or more to dispose of the lands, depending on the attractions and popularity of the particular locality to the home-seeker. Probably in no other line of business is capital called upon to work so inefficiently. Experience goes to show that where land and water have been obtained at a reasonable price the farmer under irrigation is highly prosperous, and few who are conversant with irrigation and its results will express a doubt that irrigated land is incapable of producing substantial returns to both the investor and the settler if its average fertility is immediately utilized.

It would appear that the only possible answer to what may be termed "the distressful situation" is to let the company temporarily take the place of the farmer. Economically conducted and profitable agricultural operations on a large scale are not in the experimental stage, and if something is required to put legitimate irrigation enterprise on a sound financial footing, in which the capital investment works more efficiently, and is not temporarily relegated to an unproductive state of idleness, there is good reason why they should be accepted as a part of the plan and finance of many projects. Generally speaking, the question of the company improving its lands has been scouted, but in consideration of the deplorable situation regarding finance and in the light of the advanced state of agricultural science and knowledge it would seem that this feature should rather be advocated.

It is hardly to be expected that company operations would result in such highly profitable unit returns as the efforts of the energetic and scientific farmer on a comparatively small area, but is there any reason why success to a moderate degree, to the extent of supplementing the revenue from the water rights sold, to meet the larger portion, if not all, of the demand of the carrying charges of the system should not be attained?

Perhaps the most discouraging outlook to company operations is the labor factor. In this respect depreciation in efficiency in recent years, and the too often abject display of disregard of duty, are truly discouraging features. In addition, a corporation, be it rich or poor, righteous or unrighteous, is, it may be said, always a prey to the lack of that sympathy, and friendly or neighborly helpfulness, in the protection and preservation of its property, which one man expects of another—personal characteristics which are supposed to exist among healthy-minded individuals. A company farm of large and scattered area cannot, perhaps, be under the closer supervision which prevails on the individual unit, and there will be less evidence of frugality among the employees. As a partial offset, at least, on the large farm there is an opportunity for good business organization, systematic effort, and the strict application of sound agricultural principles, and with a judicious use of modern power-operated farm machinery, thereby eliminating as far as possible the labor element, the unit cost of operations on a large scale ought to compare favorably with that of the average farmer. Further, the company would have the advantage over the farmer in that the latter usually has to pay 6% on the deferred payments of the purchase price of the land, whereas, putting the company in the farmers' position, the demand on its revenue would be only 3% on such value, assuming that the original cost of the land plus the cost of reclamation, amounts to one-half of the retail price, a not unreasonable assumption. Agricultural operations by the company would involve an additional capital charge probably of from $5 to $25 per acre, depending on the topography and the surface condition of the lands, and the kind of crops.

The improvement of the lands by the company, from the side of the colonist or homeseeker, would ameliorate largely the difficulties arising from the lack of capital, and knowledge of irrigation and farming thereunder, and eliminate many of the trying experiences of the critical period in which the thorough preparation of the virgin soil for irrigation is an essential to success. To the home-seeker the improved soil is worth materially more than in its virgin state, and the sale value to the company would, of course, be similarly enhanced.

While generally the results of irrigation investment have not been highly encouraging, there are doubtless many legitimate properties which, under a proper plan, had the lands been made immediately productive, either by colonization or by company farming, or a combination of both, would have proved good securities for the bondholder, and returned reasonable profits to the financier.

A Semicircular Coffer-Dam, Closing the Entrance of a Dry Dock under Construction

In the construction of Dry Dock No. 7, located in the Repair Basin of the Harbor of Marseilles, France, there was used to close the entrance of the dock during construction a peculiar semicircular steel framework, which was sunk into its final position with the aid of a pneumatic caisson. The location of the dry dock in the basin, with its closure, may be noted from Fig. 1. Excavation for the dock was started at the land end, and continued toward the water, where there was in existence a masonry sea wall. When the excavation approached close to this wall, it became necessary to provide some sort of closure across the front of the dock in order to make the return of the quay wall into the dock and at the same time to prevent the flooding of the dock before its completion. The water at the sea wall is about 26 ft. deep and the bottom is composed of a thin layer of mud and a very solid stratum of clay, on which the quay wall is founded. For some reason, the engineers in charge of the work decided that this clay, though of apparent imperviousness, should be penetrated further than by the usual sheet-piling coffer-dam, in making the closure around the opening.

The structure used in the closure is shown in two plan sections in Fig. 1, and in vertical sections in Fig. 2. It is composed of a series of horizontal lattice girders in semicircular form, held together with vertical lattice columns, the whole covered on its outside face with a thin

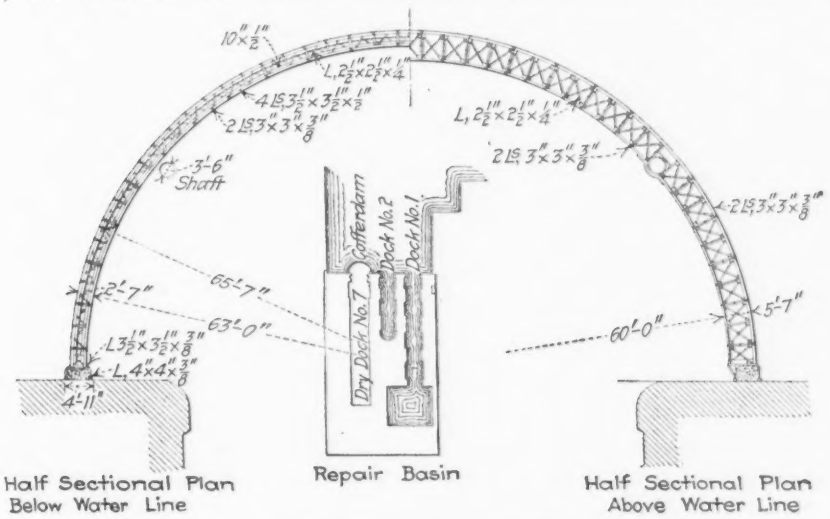

FIG. 1. LOCATION OF DOCK AND PLAN OF THE COFFER-DAM

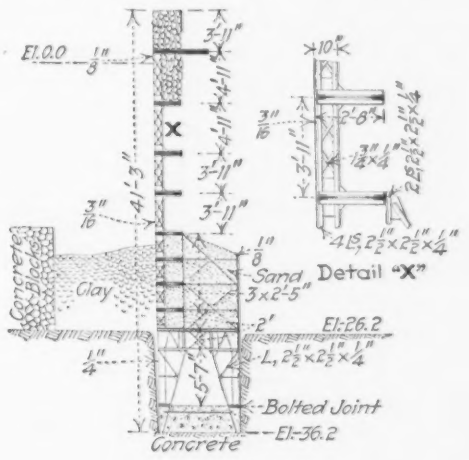

FIG. 2. VERTICAL SECTION THROUGH COFFER-DAM

sheet of steel plate, varying in thickness from ¼ in. at the lower part to ⅛ in. at the top. At the bottom of this framework is placed the working chamber of the caisson, and above this chamber is a topless box, in which is filled sand for ballast, used in weighting down the frame.

In erecting the structure, a platform was first erected on either side of where the framework was to go, and on this platform were placed a number of screwjacks; by means of these jacks the successive sections were lowered and bolted one after the other, until the cutting edges of the caisson reached a trench of proper size which had been excavated in the clay as a starting point for the caisson. The excavation was carried from that point to the final location, some 10 ft. farther down, under air, the screwjacks on the upper platform being used to aid the driving.

When the proper elevation had been reached, the bottom of the excavation was closed by a 2-ft. thickness of concrete, reinforced near the top against upward pressure, and the working chamber and the entrance shafts filled with water. Sand was then placed in the ballast box, as shown in Fig. 2, and additional stone placed across some of the upper rows of horizontal girders, as also shown in Fig. 2, the whole giving the structure sufficient weight to render it stable.

The joint between the framework and the quay wall is shown in Fig. 1. This consists of a U-shaped steel plate riveted on its flat side against the end vertical plate of the framework and provided with angles on the ends of the legs which approximately reach to the quay wall. This trough was placed after the caisson had been sunk and the interior of the U-shaped cavity was then filled with concrete, making a tight closure of the joint. As an additional protection against the outside water pressure, a footwall of concrete blocks was laid outside and parallel to the circular line of framework and the intervening space filled with clay. This is shown in section on Fig. 2.

When the operation had been completed to this point, water was pumped out from behind the dam, the quay wall returned into the dry dock, the excavation of the dry dock completed and the lock gate for the entrance of the dry dock prepared.

For purposes of taking down the frame, a joint had been left in the edges of the caisson above the cutting edge, and about the level of the concrete seal. In taking down the framework, these joints were unbolted from the inside and the whole frame raised by means of the screwjacks, and the sections removed one at a time as they came up, air being kept on in the working chamber until the chamber had cleared the ground.

The erection of the dam, including its driving, took 147 days; its raising lasted 38 days. The old structure was built by M. Vaccaro, for a contract price of $34,000, this comprising the entire work. It is described and illustrated in the Annales des Ponts et Chaussées, July-Aug., 1913, by M. Gassier, Ingénieur des Ponts et Chaussées.

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Panama Canal Excavation during September totaled 1,922,713 cu.yd., a daily average of 76,908 for each of the 25 working days. The amount of concrete laid during the month was 5710 cu.yd., and 48,221 cu.yd. of fill was placed in dams. The rainfall for September was 9.66 in.

Two Steel "Business cars" are being built by the Pennsylvania R.R. at Altoona, Penn., to facilitate the transaction of railroad business while officials are traveling. These cars are to be provided with typewriters, maps, compilations of railway statistics and other office equipment. Two other similar cars are already in use.

Regulations for Protecting State and County Highways in New York, with particular regard to the use of traction and road engines and automobile trucks and busses recently were issued by John N. Carlisle, Commissioner of Highways, N. Y., to take effect on Oct. 20. The wheels of traction and road engines hereafter must be provided with cleats not less than 2½ in. wide, not exceeding 1½ in. in height and so placed that not less than two on each wheel touch the ground simultaneously. The distribution of load on the cleats must be uniform. The regulations limit the weight of power vehicles to 16 tons, which includes the vehicle and load. A special permit must be obtained from the State Commission of Highways to move any load in excess of this figure. It is also provided that no weight in excess of 8 tons shall be carried on one axle of any vehicle, and a limit of 800 lb. per inch in width of a tire is placed on all power vehicles. Any extra weight is prohibited, except by permit of the State Commission of Highways. The width of power vehicles is restricted to 90 in., with the exception of traction engines, which may be 100 in. wide. The speed is regulated as follows: For vehicles whose weight (with load) exceeds 4 tons, 15 mi. per hour; weight of 6 tons, 12 mi. per hour, or 6 mi. per hour when equipped with iron or steel tires.

A Modern Cement and Hydrated Lime Plant

By Richard K. Meade*

SYNOPSIS—The Tidewater Portland Cement Co., in its comparatively new plant just outside of Baltimore, Md., has incorporated the very latest ideas in the design of portland-cement and hydrated-lime mills. The following categorical description of the plant by an engineer who was intimately connected with the design and construction, should be most interesting, both to cement experts and to engineers who wish to acquaint themselves with the ordinary processes of cement manufacture.

The plant of the Tidewater Portland Cement Co., is located at Union Bridge, Carroll Co., Md., although the quarries are located just across the county line—a small stream—in Frederick Co. It comprises a cement plant with a daily capacity of 3500 bbl., and a hydrated-lime plant with a daily output of 60 tons. While manufacturers may differ about the economies to be effected by certain individual machines they will probably agree that in the main the plant is well conceived and embodies those features which are considered as typical of the most recently built plants in this country. The hydrated-lime plant has been pretty generally taken as a model by other companies installing hydrating machinery and, both in the type of buildings employed and the handling of the materials, represented at the time it was built, some three years ago, a distinct advance in the construction of hydrated-lime plants, most of which have been the result of gradual development rather than of careful planning.

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The plant is connected with the Western Maryland Ry. by a short spur owned by the cement company. At the present time transportation facilities are provided by the above railroad but the Frederick branch of the Pennsylvania R.R. is only four miles away, at Keymar, and can be reached at an easy grade. Union Bridge is 45 miles from Baltimore by rail and about the same distance from Port Covington, Md., the terminus of the Western Maryland Ry. The company, therefore, is in an excellent position to make export shipments and to supply southern seaboard and gulf markets owing to its nearness to tidewater.

Raw Material

The raw materials at Union Bridge consist of limestone and shale. The limestone is supposed to belong to the Cambrio-Silurian age and lies in parallel lenses. In color the limestone varies from a dark red through white to a light blue stone. The latter is, generally speaking, the purest stone although some of the white stone is very pure and contains as much as 99% carbonate of lime. The blue stone, however, is preferred for lime making as it burns the lightest colored lime. Some of the white stone contains manganese carbonate, which blackens on burning, and the red stone contains ferruginous quartz which makes the lime even darker. There is a large vein of blue stone, however, and this is used for lime burning. The white and red limestones are satisfactory for cement manufacture. Below will be found representative analyses of stone from the various parts of the quarry.

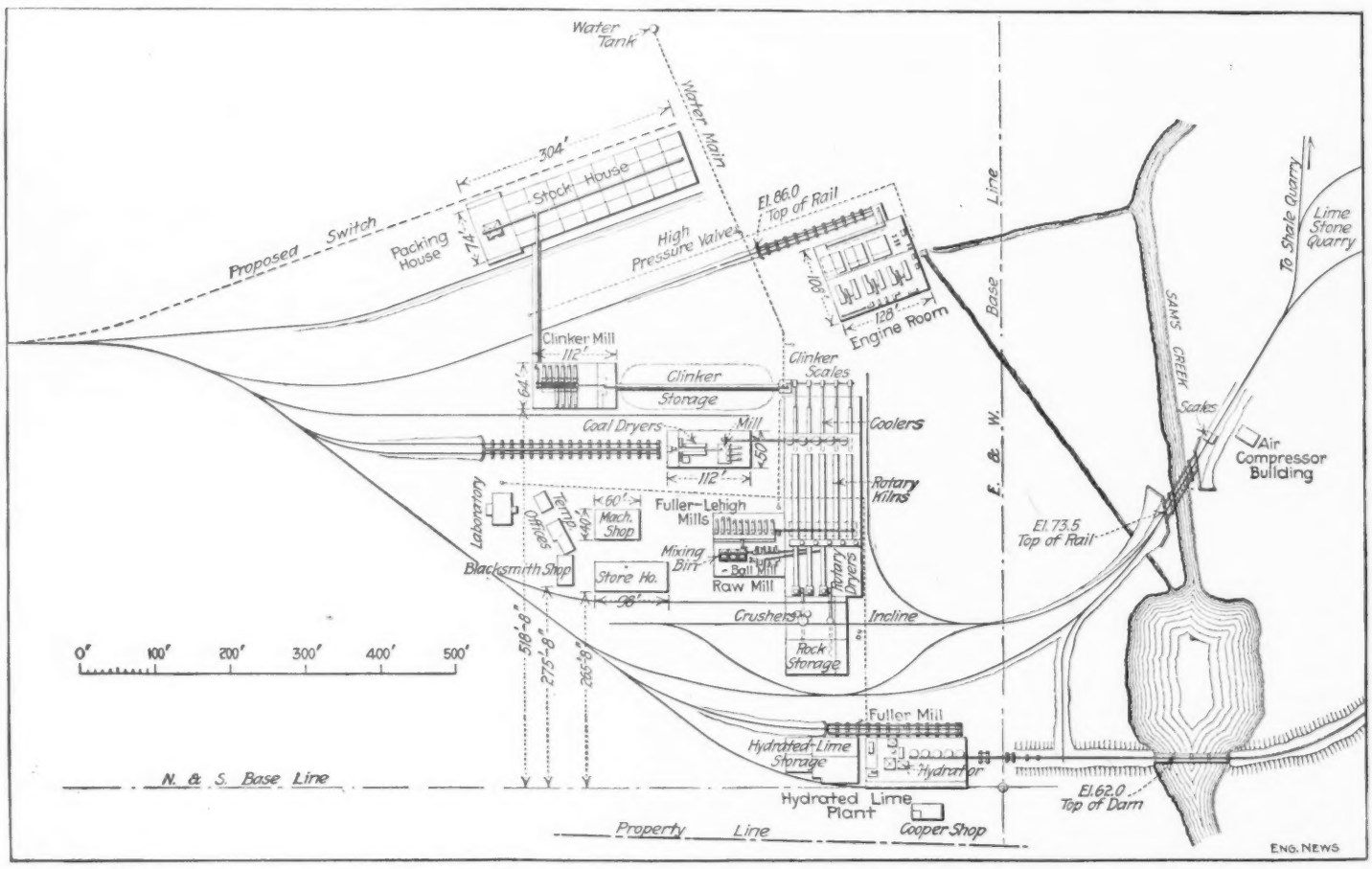


Fig. 1. General Layout of the Tidewater Portland Cement Co. Plant near Union Bridge, Md.

ANALYSES OF LIMESTONES AT UNION BRIDGE

	1	2	3	Blue Stone
Silica	2.82	2.82	10.58	0.76
Iron oxide and alumina	0.82	1.54	2.56	0.34
Lime	53.14	52.12	48.04	55.12
Magnesia	1.99	1.70	1.06	0.46
Loss on ignition	41.32	41.98	37.96	43.42

The shale is supposed to be of volcanic origin and lies immediately adjacent and to the east of the limestone. It is soft and greasy in texture and free from grit. In color it varies from blue to green under the surface and turns brown when weathered. The shale is somewhat high in alumina but as the major portion of the limestone is high in silicia, the combination is an excellent one, the shale supplying the limestone with the alumina which it lacks, and the limestone making up the deficiency in silica of the shale. The composition of the shale is very uniform and seldom varies noticeably from the following typical analysis:

ANALYSIS OF SHALE AT UNION BRIDGE

Silica	55.10
Oxide of iron	7.20
Alumina	26.24
Lime	0.96
Magnesia	1.37
Loss on ignition	6.14

The main body of the raw materials lies in two low hills which are separated by a slight depression. Stone lies in this valley also. The backbone of the hills runs in a northwesterly direction and parallel with the strike of the limestone deposits. The shale lies to the east of the limestone hills. It has been opened to a point about 200 yd. from the limestone quarry and shale for the mill is being taken from this point. The limestone quarry has been opened at the northern foot of the hills and extends across these at right angles to the strike of the deposit. The two quarries are about 100 yd. apart. The limestone quarry is being worked at two levels, one of which is above the level of the valley and the other below. The stone for the lime kilns is all hand loaded. This is necessary for lime burning, as the stone must be sized. Nothing larger than 6 in. thick can be used and if the stone is smaller than 3 in. it is unsuited to the style lime kilns employed at Union Bridge, as it will stop up the draft of the kilns.

Loading Stone—The stone for lime is loaded into 6-ton drop-bottom cars which carry the stone to the lime plant. There are three of these cars. The fine stone, or spalls not suitable for the lime plant is loaded into 10-ton side-dump cars of the general type used throughout the quarry. These carry the spalls to the cement plant where they are utilized.

The major portion of the limestone used in the cement plant is loaded by means of a 70-ton steam shovel. The shovel works on a track laid close to the face of the quarry and loads the rock on cars which run on a track parallel with this. The cars hold 10 tons and consist of skips with sloping sides which rest upon stout trucks (Fig. 2). The cars are handled by one small 12x16-in. and one 6x10-in. saddle-tank broad-gage locomotive.

The drilling is done by means of well-drilling machines and a large quantity of rock is thrown down at one time. Small hand-air drills are employed to break up the big stones and air drills are also used in the lower quarry. Air for these drills is supplied by means of a motor-driven two-stage air compressor. The motor is belt-connected to the compressor which is provided with a receiver and an unloading valve.

The shale is worked by hand and is loaded on cars similar to those used in the limestone quarry and these cars are taken to the cement plant by means of the small locomotives mentioned above.

Weighing Materials—All the raw materials are weighed by means of a 50-ton recording track-scale, the weight being punched on a small ticket. At night, these tickets are collected and as they are stamped to show whether for shale or limestone and to which plant the latter has gone, they enable an accurate record to be kept of the amount and distribution of the materials. When working full the lime plant requires about 100 tons of limestone and the cement plant approximately 1000 tons of limestone and 250 tons of shale.

The lime and cement plants are located about 200 yd. north of the quarries on a level plateau (see Fig. 1). The lime is to the west of the cement plant. A fair-sized

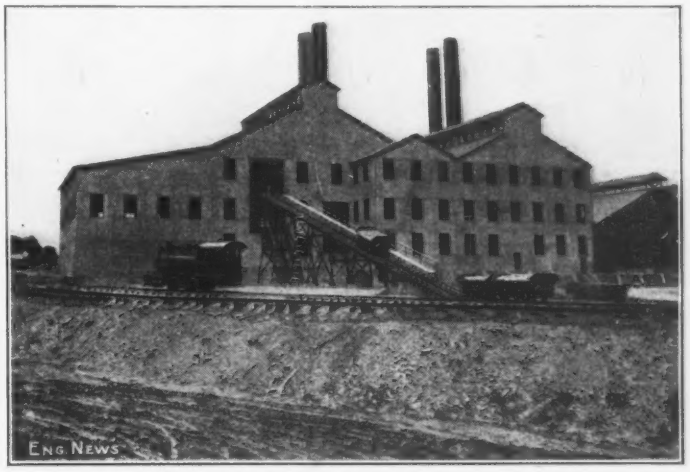


Fig. 2. Crusher Building of Cement Plant, Showing the Type of Car Carrying Rock to Crusher

stream flows between the plant and the quarries and this furnishes the water-supply for the boilers and condensers, as well as for the hydrator in the lime plant. A concrete dam has been thrown across this stream and a large basin gouged out to serve as a reservoir. The stream is crossed by a skew bridge of three plate-girder spans resting on concrete piers and abutments. Just after crossing the stream, the track branches and one switch leads to the lime plant and the other is brought to the cement plant.

Lime Plant

The stone for the lime plant is brought over in drop-bottom cars. These are run on a trestle over the track leading (by means of an incline) to the top of the kilns. A small side-dump shuttle car of 2-tons capacity is used to carry the limestone to the top of the kilns, the stone from the drop-bottom cars being dropped into this. There is also a storage for stone under the trestle and this is drawn upon for the kilns during rainy weather, when the quarry cannot be worked.

The kilns are five in number and are of the well known Keystone type, which is used pretty generally throughout southern Pennsylvania and Maryland for burning stone of the character found at Union Bridge. These kilns were built by the Steacy-Schmidt Co., York, Penn., and consist of a steel cylinder 11 ft. in diameter and 48 ft. high, lined with firebrick. The bottom of the cylinder terminates in an inverted cone and the bot-

tom of the latter is closed by shear gates. The fireboxes are located at the bottom of the cylinder on each side. The stone is fed in at the top and the hot gases from the fireboxes pass up through the cylinder and burn the lime, which later is allowed to fall into the cone where it is cooled and finally drawn out at the bottom. These kilns burn about 10 to 11 tons of lime per day and require from 2.5 to 2.8 tons of coal per day to fire them. In other words, the lime-fuel ratio is about 4 to 1.

The lime is drawn from the kilns on to large barrows. These barrows have a swinging end to allow the lime to be tipped out and by pulling back the barrow spread it evenly over the floor. The lime is allowed to remain here for a few hours to cool thoroughly when it is shoveled into an open-door crusher. This crushes the lime to a size of ½ in. and under and prepares it for the hydrator.

From the crusher, the lime is elevated to a large steel bin and from this bin it is fed automatically and evenly into a six-cylinder Kritzer hydrator. Here the lime is mixed with water and hydrated. After leaving the hydrator the product will, the greater part of it, pass a No. 100 cement test-sieve, but contains some grit. In order to pulverize this, the product from the hydrator is elevated and fed directly to a 42-in. Fuller mill, containing only two of its four balls. From the Fuller mill the hydrate passes to a large steel bin above the packer. This latter is the Bates valve-bag machine and burlap, cotton and paper bags are all employed for shipments. The paper bags hold 40 lb., but the burlap and cotton bags contain 100 lb. each.

Power to run all the machinery in the lime plant is supplied by a 100-hp. motor, which is located in a room by itself. The building is of steel, the side walls of cement stucco on expanded metal and the roof of corrugated iron. The firing floor is of reinforced concrete and extends on each side of the five kilns. Coal for the latter is brought in on the east side of the plant on a trestle and dumped here, after which it is elevated to a bin above the firing floor and wheeled from this and dumped down in front of the fireboxes.

The lime plant is connected to a lime storage, 60x96 ft. This building has a wooden frame and roof but the side walls are stucco on expanded metal, and it is provided with a loading platform upon which three large double doors open. It will hold about 1000 tons of lime, which is stored in the package. The loading track runs along the west side of the lime plant and across this is a bag storehouse of similar construction to the lime storehouse.

The company hydrates practically all of the product from its kilns and obtains for every ton of lime about 1.2 tons of hydrate. A part of the product is sold for building but the major part is sold to farmers for agricultural purposes.

Portland Cement Plant

The limestone and shale for the cement plant are hauled to the foot of the incline leading into the crusher building. This incline is provided with a chain hoist, operated by a 27-hp. motor, and provided with two dogs. These latter catch in an I-beam of the bottom of the car and pull the latter up the incline. In the crusher building are four crushers, a No. 6 Allis-Chalmers gyratory crusher for shale and a No. 9 and two No. 6 crushers of the same make and type for the limestone. The No. 9 crusher is located on massive piers above the two No. 6 limestone crushers and is so placed that the discharge from the larger crusher is divided and half goes to each of the smaller ones. The cars after reaching the top of the incline are shoved by an attendant along the top floor of the crusher and dumped into either the shale or the big limestone crusher, as the case may require. The shale crusher is nearest the incline.

The cars consist of a skip with flaring sides which rests on an iron truck. To dump the cars, hooks connected with an electric hoist are fastened in the two corners of one side of the skip and the latter is tipped by raising this side. After being dumped the cars are shoved to the opposite side of the crusher building from which they entered. Here is located the return incline. This also is provided with a chain having dog attachments which catch in the bottom I-beam of the cars and lower them to the ground. Here the cars are released and run by gravity on to a switch, where the locomotive collects them and takes them back to the quarry.

Crushers—The limestone passes from the No. 9 crusher, which reduces it to pieces 6 in. and under, to the two No. 6 crushers which break the rock down to about 3 in. and under. The discharge from the No. 6 crushers passes to a 30-in. bucket elevator. The discharge of this latter is provided with a gate and the limestone may be either passed on to the dryer bins or else into storage. This latter is located just west of the crusher and is part of the crusher building. It is 47x48 ft., and will store about 1000 tons of limestone. Underneath this storage is a tunnel provided with a belt conveyor. The stone is drawn on this when desired and passed to the apron conveyor under the crusher (which is employed for either the stone from the crusher or the storage) and thence to the dryer bins.

The shale is discharged after passing through the No. 6 shale crusher on to a 24-in. apron conveyor and from this is elevated into either the shale storage or the shale dryer bin. The shale storage is 18½x48 ft., and is provided with a tunnel underneath and a belt conveyor in this, similar to the limestone storage.

The No. 9 crusher is operated by a 150-hp. motor and the No. 6 crushers have each a 50-hp. motor to drive them. The apron conveyors are driven by individual 5-hp. back-geared motors and the belt conveyor in the tunnels under the storage by individual 5-hp. motors. The two elevators are driven each by a 15-hp. motor.

Rotary Dryers—From the crushers the stone passes to the rotary dryers. There are three of these located adjacent to the crusher building. The dryers are 7x50 ft. and each is driven by a 15-hp. motor. The dryers are so arranged that one can be used for shale, one for limestone and one for either shale or limestone. The dryers are heated by the waste gases from the kilns and are located on a line with these, the kiln and dryer being separated by a brick chamber similar to that used for the kiln stacks. A short steel flue which rests on a carriage and slides back and forth over the dryer serves to connect the dryer with the opening in the wall of the stack chamber, and to lead the waste gases from the kiln into the dryer. Each dryer has its own stock bin in which the undried rock from the crusher is stored and this is fed into the dryer gradually by means of a reciprocating automatic feeder.

These dryers have a capacity of about 500 tons of material per day each and as the waste heat from the kilns is utilized, the drying costs practically nothing, the only expense being for repairs and for an attendant to oil the bearings and motors and look after the conveyors and automatic feeds. The objection has been raised that these waste heat dryers, cut down the capacity of the kilns, but this has not been the experience at the Tidewater plant, as the kilns are often run without the dryer and the cutting out of the latter does not seem either to decrease the output or increase the coal consumption of the kilns.

Ball Mills—The raw materials drop from the dryers into conveyors, one of which is used for shale and one for limestone. These conveyors are each driven by a 10-hp. motor. The conveyors elevate the dried materials to the ball-mill bins. There are three ball mills one of which is used for shale and two for limestone. The ball mills are No. 8 Krupp mills. They are entirely without the customary screens and are only used to prepare the materials for the Fuller mills. In order to increase the screening surface, the grinding plates are bored with extra rows of holes. Each ball mill is driven by a 50-hp. motor.

Mixing Bin—The raw materials pass from the ball mills to the mixing bin. This is of steel 18x41 ft. and 21 ft. high. It is supported 8 ft. from the floor by steel columns. The bin is divided by means of partitions into nine limestone compartments each 4x8x14 ft. and nine shale compartments 4x8x4 ft. The limestone compartments are filled one at a time and an automatic sampler takes an average sample of the stone going into the bin. Usually the samples of two or three compartments are combined into one which is analyzed and these compartments are considered as a "bin" and are emptied together. The idea of using the two compartments together is to secure uniformity by averaging an inequality of one compartment with that of the other. The shale is not analyzed as its composition is so uniform as to make this unnecessary. From the analysis of the "bin" sample the percentage of shale to be used with the contents of this bin is calculated.

The weighing of the shale and limestone is done by means of a pair of Avery automatic scales. The materials are drawn out from the mixing bin by means of two screw conveyors under this, one of which runs beneath the row of shale compartments and one under the limestone compartments.

The two scales are fixed so as to dump automatically and simultaneously into a large hopper which in turn feeds into a screw conveyor. This mixes the two materials sufficiently to preserve the proportions and the final intimate mixing is done during grinding in the Fuller-Lehigh mills.

Fuller-Lehigh Mills—These mills are ten in number (Fig. 3), eight 42-in. mills and two 54-in. mills. They are located in a straight line and are fed from one large overhead bin. Each mill is driven by its own individual motor, which are all of the vertical type. For the 42-in. mills, 75-hp. vertical motors are used and for the 54-in. mills, 200-hp. motors are used. These motors have given little trouble and the experience here proves them far superior for driving Fuller mills to line shafting and the quarter-turn belt. The limestone at Union Bridge is soft and the 42-in. Fuller mills here have a capacity of from 3½ to 4 tons of materials per hour ground to a fineness of from 96% to 98% passing the standard No. 100 cement-test sieve and from 85% to 90% passing the No. 200 sieve. The 54-in. mills have a capacity about twice that of the 42-in. mills. The 42-in. mills use on an average from 68 to 70 hp. and the 54-in. mills from 130 to 140 hp.

Rotary Kilns—From the grinding mills, the raw materials are conveyed to the stock boxes above the kilns and fed from the former into the latter. The kilns are five in number, 18 ft. 6 in. between centers, 8 ft. in diameter and 120 ft. long each. The first three kilns are so arranged as to pass on their waste gases to the dryers, as stated before, while the last two kilns have only stacks. The first three kilns are, however, provided with stacks also so that they can be used without the dryers at any time. A large plate damper can be lowered when it is desired to cut off the dryer, while a drop damper ("stopper" damper) on top the kilns stack closes these at will and forces the waste gases through the dryer. The kilns were made by the Vulcan Iron Works and are supported in four places.

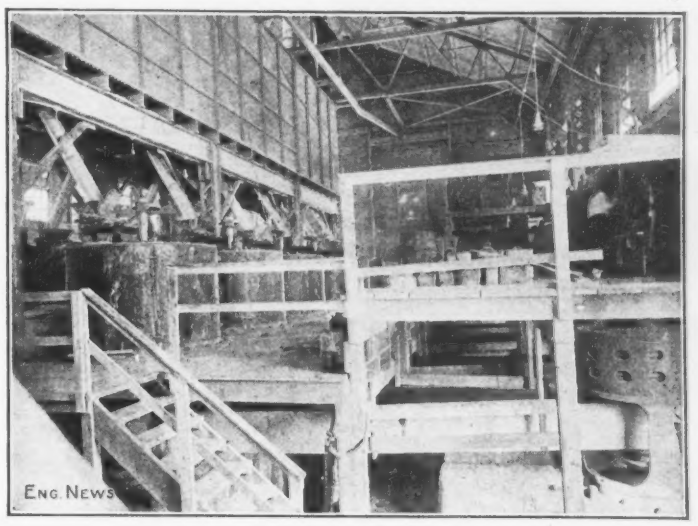


Fig. 3. Fuller-Lehigh Mills Pulverizing Stone for Rotary Kilns

A feature is the end construction of the kilns, designed by the writer. It is shown in Fig. 4. It is the usual practice to fasten an angle on the end of the kiln both to stiffen the end of the kiln and also to hold in place the firebrick lining. The hot clinker usually wears away the brick rapidly and also the angle-iron, making it necessary to cut out the angle-iron and rivet in a new one. This, of course, takes time. In designing the kilns of the Allentown Portland Cement Co., the writer suggested the placing of this angle-iron on the outside of the kiln and bolting to it heavy iron plates to hold in place the firebrick lining. This same design has been followed with the five kilns at the Tidewater plant.

The kilns are driven by independent 30-hp. variable-speed motors. The drive to the raw materials feed mechanism is connected to this motor so that when the kiln stops the feed also stops. The controller is located in front of the kiln so that it is handy for the kiln attendant. The speed of the kiln may be varied from one revolution in 42 sec. to one revolution in 2 min. The kilns are heated by pulverized coal. This is contained in five steel bins

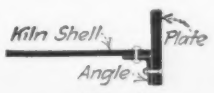


Fig. 4.

12 ft. in diameter and is fed out of these with a screw conveyor. This latter is driven by a small 2-hp. motor and a double-cone speed regulator is used to control the amount. This it does by increasing or diminishing the revolutions per minute of the screw. The air for carrying the coal into the kilns is supplied by five pressure blowers, one for each kiln. Each blower is direct connected to a 10-hp. motor. These blowers are capable of supplying practically all of the air necessary for combustion.

The motors for driving the kilns are located in a tunnel below the kiln floor. A screw conveyor runs in front of the kiln stacks to carry off the dust which collects in these.

The kilns have a capacity of about 31 bbl. of clinker per hour with a coal consumption of 90 lb. of coal per bbl. This latter figure is based on the car weights of coal as indicated in the invoices and not on dry pulverized coal, which would be of course a much lower figure. It is estimated that the average consumption of heat per barrel of clinker produced is approximately 1,200,000 B.t.u.

Coolers—From the kilns the clinker drops directly into the coolers. These are located below and on a line with the kilns. They are 6 ft. in diameter and 50 ft. long. They are lined with firebrick for the 30 ft. nearest the kilns. The last 20 ft. is kept cool by means of a spray of water. The discharge end of the cooler is perforated with 1-in. holes for about 3 ft. and is provided with a large ring to hold back the clinker. The smaller pieces of this latter fall through the openings while the larger ones are retained in the cooler and are broken up by an attendant. When the coolers were first operated they were unlined and some trouble was experienced from the warping of the end next to the kiln, trouble was also experienced with the chute leading from the kiln into the cooler. The cooler is now lined with cheap firebrick for 30 ft., as explained above, which lasts fairly well and the chute is made of old T-rails over which firebrick are laid. The water is introduced into the cooler so as to strike the clinker about where the firebrick lining ends. The coolers are driven each by a 10-hp. back-geared motor.

Clinker Scales—The clinker drops out of the cooler on to an inclined pan conveyor and is elevated to the clinker scales. These are automatic and one is provided for each kiln. By this means, an accurate record is kept of the production of each kiln at all times and any falling off in production can be immediately looked into. These scales have worked very satisfactorily. They require occasional looking over by a repairman or foreman but the weights check very well with the inventories. The scales also were made by the Avery Scale Co.

Clinker Storage—The scales dump on to a belt conveyor which conveys the clinker to the foot of the clinker tower. Here it is elevated by means of an ordinary bucket elevator and distributed by means of a belt conveyor provided with a movable tripper, over any desired part of the clinker storage. The clinker storage is 219x64 ft., and is of structural steel with a galvanized-iron roof. A tunnel runs underneath this storage and openings in the roof of the tunnel permit the drawing of the clinker on to a belt conveyor which conveys the clinker to the clinker mills. This belt also extends back to the clinker tower to a point below the discharge of the belt from the clinker scales so that clinker may be run direct from the scales to the clinker mill without passing it into storage.

Gypsum Mixing—The clinker is dumped from the belt running beneath the clinker storage into the hopper of an automatic scale. This weighs and records the total weight of clinker entering the clinker mill and also, by means of a measuring device, adds to the clinker the desired amount of gypsum. The gypsum itself is stored in a large bin located above the scales. This bin is formed by one end of the clinker mill which end has been provided with massive concrete walls for this purpose. A track runs alongside of the gypsum storage and the cars of gypsum are brought in on this and unloaded into a chute in the side of the building. A bucket elevator catches the gypsum as it comes through this and elevates it into the storage bin.

Final Grinding—The mixture of clinker and gypsum drops from the hopper of the automatic scales into the boot of a bucket elevator and it passes from this latter to a screw conveyor which distributes it along the entire length of the stock-boxes above the Fuller-Lehigh Mills. There are ten of these mills located in a double row in the center of the building. Four of these mills are in one row and six in the other. The mills are of the 54-in. "Dreadnaught" type and each mill is driven by a 200-hp. vertical motor. The motors are located along the two sides of the walls of the mill. In order to facilitate repairs and to bring the parts in easily, an I-beam is supported on the steel frame of the stock bin, just above the center line of each row of mills and a chain block runs in a trolley along this. The same arrangement is also provided in the raw mill.

The 54-in. Fuller-Lehigh Mills take the clinker just as it comes from the kilns and no preliminary crusher is necessary. The cement is ground to such fineness that 94 to 96% of it will pass a standard No. 100 cement-test sieve and from 80 to 85% the No. 200 sieve. The mills here have an output of from 15 to 18 bbl. per hr., depending on the clinker.

An ammeter is placed in plain sight of the operator in order to avoid overloading the mills and consequently stalling of the motors. Where this latter occurs, it is necessary to clean out the mill which necessitates taking off the casing and screens. These large Fuller Mills are provided with a set of fans located below the screens which suck air through the latter and force it out with the ground cement through the discharges port of the mill. It was found on operating a few of the mills that they could not be discharged directly into an ordinary screw conveyor as is usual with the older type of 42-in. Fuller mill and the Griffin mill, owing to the dust blown out by these fans. A large box or dust chamber 8x8 ft. in cross-section and running the full length of the conveyor was then built on the latter, and two 30-in. and one 24-in. stack, reaching up outside the roof of the building were placed on this. The conveyor covers were then removed and the mills discharged directly into the box, which arrangement permits the dust to settle while the air and steam escape from the stacks.

Stock House—The cement is conveyed from the clinker mill to the stock house by means of an incline belt conveyor running in a bridge. Here it is distributed into bins by means of a screw conveyor. The stock house is 256x74 ft. and contains the packing machinery and 32

bins. These have a capacity of 2000 bbl. each and are arranged in four rows of eight bins each. A tunnel runs lengthwise through the middle of each row of bins. In the bottom of the tunnel is a 12-in. screw conveyor covered by an iron grating and the cement is run into this through openings and chutes, which are closed by means of slides. The bins have sloping bottoms and can be emptied by gravity with the exception of about 200 bbl. which remains and must be shoveled out. The walls of the building, which are of massive concrete, form one side of the outside row of bins. The bin partitions are of 2-in. plank supported by a framework of steel.

PACKING—The packing department is located at the north end of the stock house. The packing machinery (Fig. 5) at the present time consists of two Bates valve-bag packers (with a place left for two more) and one Iron King barrel packer. The bags are tied by means of wire-ring ties. This is done by a boy on a special machine. A good boy can tie 5000 bags per day. The

FIG. 5. BAG FILLERS AT TIDEWATER CEMENT MILL

two bagging machines are run by one 30-hp. motor and the two bag-tying machines by a small 2-hp. motor. Loading trucks run on both sides of the packhouse.

BAG CLEANING—The bags are cleaned by contract with the National Bag Co., of Easton, Penn. This concern has a large cleaning wheel located at the plant and receives, sorts, counts, cleans and delivers the returned bags to the company in bundles of 50 each. They also repair all torn bags, giving the customer credit for all bags which they can mend. This system helps to eliminate much of the friction between cement companies and their customers over the return of the bags, as the count of the bags is not only that of a disinterested third party, but it is directly to the interest of the bag cleaner to give the customer full credit for all bags returned which can be used, as the cleaning company is paid by the bag and then only for such bags as they turn over to the cement company in good condition. So it is to their interest to repair and turn in as many as possible.

FUEL PREPARATION—The fuel mill in which the coal for firing the kilns is pulverized is located 20 ft. from the kiln building and connected with it by a bridge over which the pulverized coal is conveyed to the kiln bins by means of a screw. The coal from the mines is run up on a long double-track trestle and dumped into an open-air storage. Under this storage is a tunnel and the coal is tapped through the roof of this on to a belt conveyor which carries it into the coal mill. Here it is passed first through a set of rolls and then weighed and dried. The weighing is done by means of recording automatic scales. The coal is dried by means of two coal dryers. One of these dryers, invented by the writer, consists of an outer shell 7 ft. in diameter and four tubes each 27¼ in. in diameter. The outer shell ends at the firebox but the tubes extend through this and terminate in a feed chamber. The coal is fed into this latter and so into the tubes by the revolutions of the dryer, and works its way through these. The hot gases pass up from the firebox around the tubes and in between these and the outer shell until they come to the end of the latter where they reverse and enter the tubes, passing through these to the stack. This dryer (which is covered by a patent) shows large output and good efficiency.

After drying, the coal is pulverized in Fuller mills, three 42-in. mills each driven by its own 75-hp. motor being employed. These mills here give an output from 3 to 3½ tons per hour and require about 50 hp.

POWER PLANT—The power plant is located at a convenient distance away from the other buildings. The equipment consists of three 1000-kv.-a. generators, direct connected to 23x46x48-in. Corliss cross-compound engines and five 440-hp. vertical water-tube boilers. The boilers are equipped with Roney stokers and these latter are motor-driven, although an engine is also provided in case of a breakdown of the motor. The coal comes in on a trestle alongside of the power house. A tunnel, in which is located a belt conveyor, runs under the pile and the coal is tapped through openings in the roof of the tunnel on to this. The belt conveyor dumps the coal into automatic scales and after being weighed by these the coal is elevated by means of a combination V-bucket elevator and scraper conveyor into the bunkers over the stokers, whence it is spouted to the latter. The rest of the equipment of the boiler house consists of two boiler-feed pumps, two circulating pumps, one fire pump, and one feed-water heater.

The three main engines are located side by side. The vacuum is maintained by means of a 57-in. barometric condenser, located outside the building. The water for this is supplied by means of two 10-in. centrifugal engine driven pumps. There is also a dry-air pump. The power plant is supplied with a 110-kw. motor-driven and also a 110-kw. steam-driven exciter. The latter, of course, is only used in starting the plant after a complete shutdown. A small 150-hp. engine, direct connected to a 150-kva. alternating-current generator, is installed. It is found useful when only the pack house or the kilns are in operation, or for lighting when the plant is shut down.

The switchboard is provided with the usual circuit breakers, switches and indicating apparatus and is divided into 17 panels. There are in addition to the usual equipment a voltage regulator, frequency indicator, a recording wattmeter and one curve-drawing wattmeter. By means of the recording wattmeter and the automatic coal scales, an accurate record of the efficiency of the power plant may be kept.

The current employed is 550 volts, three-phase, 25-cycle and alternating. All machinery throughout the plant is motor-driven, even each conveyor and elevator having its own motor. For this latter purpose back-geared motors

of the squirrel-cage type are used. The gears to date after practically one year's continuous running do not show appreciable wear.

The electrical wiring throughout the plant is done in a substantial manner. The switches are incased in steel boxes together with the distribution panels. There is a recording wattmeter which records the power used by each department.

CONSTRUCTION—The buildings throughout the plant are of steel frame covered with cement-lime stucco on expanded metal (Fig. 2). The roofs, for the most part, are board covered with patented roofing, exceptions being the kiln building and the lime plant which are of corrugated iron. The crusher building, raw storage, kiln and dryer building, and the raw mill are connected without partitions. The power plant has the engine room divided from the boiler room by means of a stucco partition.

The laboratory occupies its own building which is an attractive one-story, bungalow style, building of stucco. There are three rooms, the chemical and physical laboratories and the chemist's office and a large basement.

PERSONNEL

The plant was built by the Republic Finance Co., for the Tidewater Portland Cement Co. The Fuller Engineering Co. prepared the plans under the general direction of the writer and Howard C. Tompkins, Chief Engineer of the Republic Finance Co.

Combination Concrete and Cast Iron for Columns and Arch Ribs

Three or four years ago Dr. F. von Emperger, of Vienna, Austria, proposed making reinforced-concrete columns with a core of cast iron; the core, as proposed, was so large that the column would in effect be a cast-iron column strengthened by a shell of hooped concrete to toughen it. He did not limit the idea to columns, but extended it also to compression members such as the ribs of arch bridges.

During the past two years this idea has been carried into practice in at least two important cases. An arch bridge of 138-ft. span, the Schwarzenberg bridge, was built during the last winter in Leipzig, Germany, as a footbridge over the railway tracks near the International Architectural Exhibition; it was completed in April, 1913, and has been in use since then. A commercial building in Vienna, which by this time is probably completed, the Ericson Building, has its columns made of the type described.

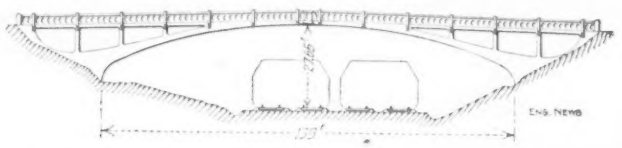


FIG. 1. SKETCH OF SCHWARZENBERG BRIDGE, LEIPZIG; FIRST STRUCTURE OF COMBINATION CAST-IRON AND REINFORCED CONCRETE

Several arch bridges are now under construction on this system. One of the largest is a bridge at Deep, in northeastern Germany, illustrated (after a sketch) by Fig. 2. This has a span of 197 ft. A smaller bridge, being built at Unterleiterbach, has the arches above the roadway, giving an appearance something like a bow-string truss bridge without diagonals.

Experiments made on members built according to the combination cast-iron-and-concrete system have shown very remarkable toughness and high strength. They show in the testing machine a complete absence of the brittleness which characterizes the ordinary crushing failure of cast-iron columns. The failure loads of such columns, after deducting the load-carrying capacity of the hooped concrete shell, were over twice as high as the capacities of the unreinforced cast-iron columns.

In the diagram Fig. 4 is shown by the uppermost curve the column strength which the cast-iron member of the combination column will realize (in the combination), according to Mr. Von Emperger; the formula of the curve is also given. He bases this curve on iron having a normal cube crushing strength of 142,000 lb. per sq.in. (10,000 kg. per sq.cm.), which strength, he states, is readily attainable with a strong grade of cast-iron. On

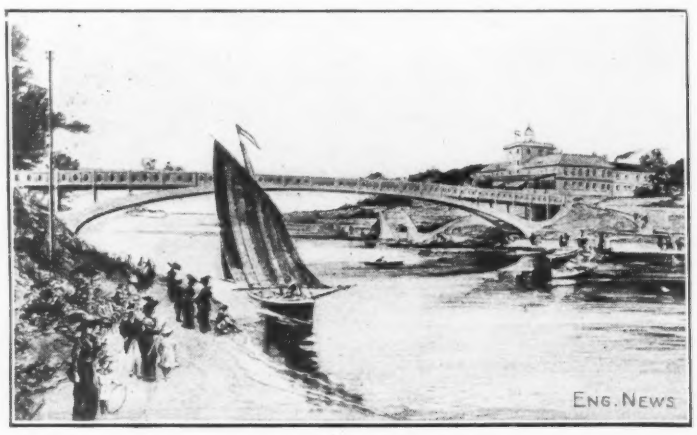


FIG. 2. REINFORCED-IRON ARCH BRIDGE AT DEEP, GERMANY, NOW BUILDING

the diagram are given also the failure curves for steel columns and plain cast-iron columns. The three curves just mentioned are taken direct from a diagram accompanying a paper presented by Mr. von Emperger before the German Iron Founders Association at Eisenach, Germany, a few weeks ago.

In the same paper, however, he gives also a chart (or rather a chart and a table which must be used together) for use in designing columns of his system. Applied to any specific case, the chart gives results quite different from the recommended (upper) curve in Fig. 4. He states that the chart was used in designing the Ericson Building and other structures of his system so far built or designed. We may derive from this chart a curve of allowable stress for different values of length-ratio—or more properly two curves, as two sets of coefficients are given in the table. We have plotted this pair of curves in Fig. 4, being the two heavy curves in the lower left-hand corner of the diagram; one of them is for a cast iron having a cube crushing strength of 128,000 lb. per sq.in. (9000 kg. per sq.cm.), and the other for a cast iron of 107,000 lb. per sq.in. (7500 kg. per sq.cm.). If the safety-factor of four (which Mr. von Emperger recommends in his paper as being appropriate for use with this system) is applied to these two curves of working stress, two curves of ultimate strength are obtained, which we have also drawn in Fig. 3 (the two steeply slop-

ing dash lines). These curves differ radically from the upper column curve which Mr. von Emperger presents as characteristic for columns of his system.

However, the working stresses represented by the dashed curves are still remarkably high, and permit of very economical design. It is to be noted also that these stresses apply to the iron alone, and that the capacity of the column is counted as being further increased by the compressive capacity of the hooped-concrete shell. The latter is computed by allowing a unit-stress of 550 lb. per sq.in. on the full cross-sectional area of the concrete.

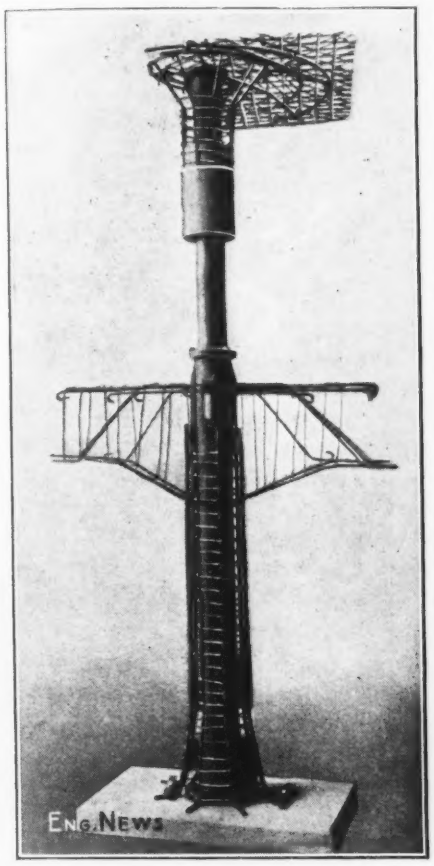


FIG. 3. MODEL OF REINFORCED-IRON COLUMN AND ADJOINING FLOOR REINFORCEMENT

In the Ericson Building steel beams and a concrete slab floor were used. But the possibilities of the system for use with reinforced-concrete floor construction have been studied by its author, and a number of designs made correspondingly. Fig. 3 is a model of the columns and adjoining floor reinforcement for such a structure. There should be no particular difficulty in making suitable connections between the reinforcing rods of the floor and the core and reinforcing rods of the column. The model is of interest, however, in showing the adoption of a radial-reinforcement floor system similar to systems in use in this country.

A prominent feature of the compression tests which were made by Mr. von Emperger on reinforced-iron columns is the toughness of the column. When such a column fails, it does not break, shatter or shear off, but bends outward into a very decided sinuous curve. This result is due to two distinct causes: first, the restraint against bursting or diagonal shearing afforded by the hooping steel in the concrete shell; second, the bending resistance given by the longitudinal reinforcing rods in the concrete shell. The influence of the latter element was particularly apparent in a test on a column whose core was made up of several pieces placed end to end and tested in comparison with a similar column with integral core; the strengths obtained were identical.

⁂

New York Rapid Transit—A summary of the traffic on the city subway and the Manhattan and Bronx elevated railroads has been made public. It shows that the subway for the year ending June 30, 1913, carried 327,471,510 passengers and the elevated lines for the same year 306,845,006. The week-day average was 963,152 passengers on the subway and 902,485 passengers on the elevated lines. The increase for the year was 24,497,654 on the subway and 2,574,165 on the elevated.

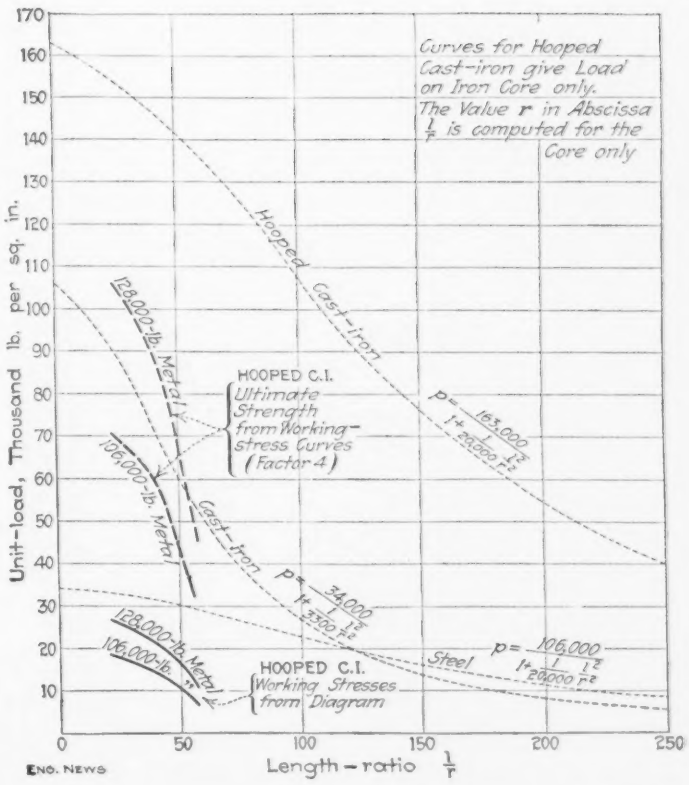

Curves for Hooped Cast-iron give Load on Iron Core only.
The Value r in Abscissa l/r is computed for the Core only
Unit-load, Thousand lb. per sq. in.
Length-ratio l/r
Hooped Cast-iron
128,000-lb. Metal
106,000-lb. Metal
Cast-iron
HOOPED C.I. Ultimate Strength from Working-stress Curves (Factor 4)
HOOPED C.I. Working Stresses from Diagram
Steel
ENG. NEWS

FIG. 4. COLUMN-FORMULA DIAGRAM, SHOWING STRENGTHS OF REINFORCED CAST-IRON COLUMNS ACCORDING TO F. v. EMPERGER

(The heavy lines in the lower left-hand corner correspond to results given by the dimensioning diagram used for designing columns of Ericson Bldg.; if these are based on a safety-factor of 4, the heavy dash lines represent the ultimate strengths. The upper dotted line is the compressive strength of such columns as claimed by F. v. Emperger.)

⁂

The Snoqualmie Tunnel in the Cascade Mountains, on the line of the Chicago, Milwaukee & Puget Sound Ry., has made good progress, according to the company's annual report for the year ending June 30, 1913. The tunnel will be 11,700 ft. in length and has been driven for 3500 ft. from the west end. The necessary machinery and equipment for drilling operations from the east end are in position, and work will soon be under way. Concreting is now in progress, and it is estimated that the tunnel will be completed within two years. This will shorten the line 3.6 miles and eliminate heavy grades on the present line between Rockdale and Keechelus. It will also do away with snow troubles, which, in the Cascade Mountains, are confined to that portion of the line to be abandoned upon completion of the tunnel.

The Solar Power Plant at Meadi, near Cairo, Egypt, built by Frank Shuman, of Philadelphia, was put in operation July 11 with elaborate ceremonies. The plant as there constructed covers several acres of land on the left bank of the Nile and consists of a series of reflectors and absorbers, a 100-hp. low-pressure steam engine, a condenser and a chain-driven pump. (An experimental plant erected by Mr. Shuman at Tacony, near Philadelphia, Penn., was described in "Engineering News," Sept. 21, 1911. Tests on the unique design of engine for this low-pressure service were reported in the issue of June 6, 1912.) Full steam was raised in 15 minutes when the engine was started; in five minutes more the plant was delivering 6000 gal. of water per minute against a head of 30 ft.

In the Egyptian plant there are five reflectors, each 204 ft. long, of parabolic cross-section and built up from a series of glass mirrors; the frames are spaced 20 ft. apart, and the total surface exposed to the sun is 13,500 sq.ft. The frames are connected with one another and geared to an engine with thermostatic control, so that the reflectors follow the course of the sun throughout the day. Along the focal line of each reflector is the absorber, or low-pressure boiler. At first this was a box of ⅜-in. zinc, but more steam was raised than figured on during the early trials of the plant so that the water was violently ejected from the boiler and the zinc softened before the trouble could be remedied. Steel boilers of ¼-in. plate, oxyacetylene welded at each joint and strongly braced, were substituted for the zinc.

The Theory of the Penetration of Heat in Solid Materials

By L. R. Ingersoll*

The purpose of this article is to discuss certain problems in heat conduction of engineering interest; and to put the theory of them in such form as will permit the easy solution of many specific examples of common occurrence.

The elementary theory of heat conduction through a plate or wall, as through the sides of a furnace or ice-house, whose surfaces are at constant temperatures, and the algebraic expressions for the simple heat flow, are known to every engineer, while more or less has been written also about the more complicated phases of the subject such as edge or corner losses† and the like. Unfortunately, however, such "steady state" problems are by no means the only ones with which the engineer is confronted. The rate at which heat will penetrate into the interior of a body whose surface has been more or less rapidly heated—be it a wall under fire test, a firebrick in a regenerator, a casting undergoing annealing, a huge concrete dam in the summer's heat, a railroad cross-tie in process of treatment, or any one of a hundred similar cases—is a problem which is continually appearing in almost every line of work and in various forms, each demanding a solution. While such solutions frequently require experimental tests, it need hardly be pointed out that a knowledge of the underlying laws should simplify such tests, and at the same time render them much more effective.

The fundamental theory underlying this type of problem has been available in mathematical treatises for many years, but, so far as the writer is aware, has not yet been much made use of in engineering literature. It is the writer's purpose to apply this theory, either directly or by suitable connecting reasoning, to a number of specific cases, and to show that its predictions and laws are well justified by experiment. The subject will be taken up from two slightly different standpoints according as we desire to know the temperature at any time (1) inside a body at various depths below a heated surface, or (2) in the middle of a plate or wall both whose faces are heated. By a simple extension of the latter case, the laws can be deduced which apply to a wall heated on one side as by fire, in other words, what we shall term the thermal "theory of the fireproof wall."

Flow of Heat Inward from a Heated Plane Face

Starting with the simple fundamental law for the flow of heat in the steady state—namely, that the amount of heat conducted varies directly as the conductivity, area, time and temperature difference, and inversely as the thickness—it is not particularly difficult to derive the solution for this case with the aid of Fourier's Series. For such derivation, however, the reader is referred to any treatise on heat conduction‡ where he will find it given in the form

$$T = T_o \frac{2}{\sqrt{\pi}} \int_{\frac{x}{2h\sqrt{t}}}^{\infty} e^{-\beta^2} d\beta$$

This means that for a body initially at the zero of our temperature scale, whose plane surface is suddenly heated to and maintained at T_o, the temperature T at a distance x from this surface will be given t seconds later by this integral. As to the meaning of h, a little thought will serve to show that inasmuch as the temperature of the substance must be raised by the heat wave as it travels into the body, the rate of this penetration will depend not only on the conductivity, but on the specific heat and density of the material as well. This is taken account of in the constant h which is defined by the relation

$$h^2 = \frac{k}{c\rho}$$

k, c and ρ being respectively the conductivity, specific heat and density of the material. The quantities x, h and t being known, T can be determined. Tables I and II give the values of this integral, and of the constant h^2, or *thermal diffusivity*.

TABLE I. VALUES OF INTEGRAL $E = \frac{2}{\sqrt{\pi}} \int_{\frac{x}{2h\sqrt{t}}}^{\infty} e^{-\beta^2} d\beta$

$x/2h\sqrt{t}$	E	$x/2h\sqrt{t}$	E	$x/2h\sqrt{t}$	E
0.00	1.000	0.45	0.525	1.40	0.048
0.02	0.987	0.50	0.480	1.50	0.034
0.04	0.955	0.55	0.437	1.60	0.024
0.06	0.932	0.60	0.396	1.70	0.016
0.08	0.910	0.65	0.358	1.80	0.0109
0.10	0.888	0.70	0.322	1.90	0.0072
0.12	0.865	0.75	0.288	2.00	0.0047
0.14	0.843	0.80	0.258	2.10	0.0030
0.16	0.821	0.85	0.229	2.20	0.0019
0.18	0.800	0.90	0.203	2.30	0.0011
0.20	0.777	0.95	0.179	2.40	0.0007
0.25	0.724	1.00	0.157	2.50	0.0004
0.30	0.671	1.10	0.120	2.60	0.0002
0.35	0.621	1.20	0.090	2.70	0.0001
0.40	0.572	1.30	0.066	∞	0.0000

TABLE II. VALUES OF THERMAL CONDUCTIVITY CONSTANTS IN C.G.S.* UNITS.

Material	Temperature, Deg. C.	Conductivity, k	Diffusivity, h^2
Air	0	0.000055	0.179
Aluminum	18	0.480	0.826
Brass (yellow)	0	0.204	0.339
Brick (firebrick)	0–800	0.0040	0.0074
Brick (in masonry)	..	0.0020	0.0050
Concrete (cinder)	..	0.00081	0.0031
Concrete (stone)	..	0.0022	0.0058
Copper	18	0.918	1.133
Cork (ground)	..	0.00012	0.0017
Glass (ordinary)	..	0.0024	0.0057
Granite	..	0.0081	0.0155
Ice	..	0.0052	0.0112
Iron (wrought or mild steel)	..	0.1436	0.173
Iron (cast, also high-carbon steel)	..	0.108	0.121
Lead	18	0.0827	0.237
Limestone	..	0.0050	0.0092
Magnesium carbonate (85% steam-pipe covering)	..	0.00017	.....
Marble (white)	..	0.0050	0.0090
Nickel	18	0.142	0.152
Rock material, average	..	0.0042	0.0118
Sandstone	..	0.0050	0.0133
Silver	18	1.006	1.737
Snow (fresh)	..	0.0003	0.0033
Soil (average, damp)	..	0.0037	0.0055
Soil (very dry)	..	0.00088	0.0031
Water	..	0.00143	0.00143
Wood (dry pine—across grain)	..	0.00009	0.00068
Wood (dry pine—with grain)	..	0.00030	0.0023

* The use of this system is almost compulsory in cases where thermal diffusivity is involved, since it is the only one in common use which is consistent in its choice of fundamental units. Thus the steam engineer's conductivity unit of the B.t.u. per hour, per sq. foot, per degree F., per inch in thickness, is not available in this case since it involves two different units of length, i. e., the inch and foot. Similar objections may be raised against most of the other units in common use with the exception of the C. G. S.

Most of the values for metals are those of Jäger and Diesselhorst (Abh. d. phys-tech. Reichsanstalt, Vol. 3, p. 269, (1900). The others have been compiled from various sources. When not otherwise specified, ordinary temperatures are assumed.

Examples—The use of these tables is best shown by solving some specific examples:

(1) A massive granite block at 20° C. (68° F.) has one face (rapidly) heated to 200° C. (392° F.). What will be the temperature at a depth of 10 cm. (4 in.) after one hour?

*Associate Professor of Physics, University of Wisconsin, Madison, Wis.

†Carl Hering, "Trans. Am. Electrochem. Soc.," Vol. 14, p. 215 (1908).

‡See, for example, "The Mathematical Theory of Heat Conduction, with Engineering and Geological Applications," by L. R. Ingersoll and O. J. Zobel, p. 78 (1913).

Since the theory is based on the assumption of an initial temperature of zero the temperature scale must be shifted in this case by subtracting 20°, which will be added again later. Taking h^2 from Table II as 0.0155, t as 3600 (seconds) and x as 10 (cm.), the quantity $x/2h\sqrt{t}$ becomes 0.67. This gives, from Table I, $E = 0.31$, hence the rise in temperature would be $T = 180\,E$, or 61°, making a final temperature of 81° C. (178° F.)

(2) The surface of a dry soil initially throughout at 6° C. (43° F.) is cooled to −20° C. (−4° F.). How long before water pipes at a depth of 152 cm. (5 ft.) will be in danger of freezing?

Here we have, after shifting the temperature scale,

$$-6 = -26\,E, \text{ or } E = 0.23$$

From Table I, then, $x/2h\sqrt{t} = 0.85$, which, with $h^2 = 0.0031$, gives $t = 2{,}600{,}000$ seconds or 30 days.

Experimental Verification—An inspection of the integral E shows that if the distance x is changed in the same ratio as the square root of the time, the value of the integral will remain unchanged; in other words, a given temperature will penetrate to *twice* the depth in *four times* the time, etc. This "law of times," as can be seen later, is of quite general application in cases of conduction from a heated surface. Moreover, while our results apply primarily only to relatively homogeneous material, the following deductions from some experiments performed at the Underwriter's Laboratory in Chicago, by C. A. Snow, seem to show that the theory holds with a fair degree of approximation even for cellular structure.

In these tests, cellular blocks of concrete and tile were exposed to the heat of a furnace on one side while the temperature rise in the material was measured by thermocouples embedded at various distances from the heated surface. From Snow's curves,* it is seen that, for concrete and tile blocks whose front faces were heated to 1300° F. and 1600° F., respectively, the distances to which certain temperatures would penetrate in 2¾ hours and in four hours are given by Table III.

TABLE III. RESULTS OF HEAT-PENETRATION TESTS

Interior	Observed distance in 2¾ hrs.	Observed distance in 4 hrs.	Computed distance for 4 hrs.
Concrete Block No. 1.			
400° F.	3.82″	4.65″	4.60″
600	2.52	3.10	3.04
800	1.52	1.86	1.83
Tile Block No. 2.			
400	5.90	6.70	7.12
600	4.56	5.20	5.50
800	3.46	3.96	4.17

The "computed distance" was found by increasing the first of the observed distances by the ratio of the square roots of the times, i.e., $\frac{2}{1.66}$. The data for the tile block may be also used to exhibit this law in another and better way by noting the time necessary for the temperature to rise to certain values at several fixed distances. This gives Table IV.

TABLE IV. TEMPERATURE RISE IN TILE BLOCKS

Interior Temp.	Time: Observed at 1.81 in.	Observed at 3.75 in.	Computed for 3.75 in.	Observed at 5.81 in.	Computed for 5.81 in.
200° F.	0.13 hr.	0.47 hr.	0.56 hr.	1.23 hr.	1.34 hr.
300	0.17	0.65	0.73	1.85	1.75
400	0.20	0.87	0.86	2.65	2.06
600	0.33	1.55	1.41	....	....

The computed times are in the ratio of the squares of the distances. The agreement with the observed times is reasonably good in all cases. We have tacitly assumed that the other faces of the block are far enough away to be without influence on the result—it will be remembered that our theory calls for a body of large extent and therefore only a single effective face—and this will be true only if they are sufficiently far away from the point as compared with the heated surface; this probably has something to do with the larger discrepancies at the greater distance.

*The writer is indebted to G. W. Riddle, of the Underwriter's Laboratory, for an account of this work.

Flow of Heat Inward from Two Heated Faces

If a plate or slab of thickness l and initial temperature zero, have both its faces suddenly heated to and kept at T_o, the temperature T in the middle plane, which will obviously be the last part of the body to heat up, may be obtained from the equation*

$$T = T_o\left(1 - \frac{4}{\pi}10^{-0.434\frac{h^2\pi^2 t}{l^2}} + \frac{4}{3\pi}10^{-0.434\,9\frac{h^2\pi^2 t}{l^2}} - \ldots\right)$$

t being the time in seconds and h^2 the thermal diffusivity. To simplify computation, the values of this series have been tabulated as in Table V.

TABLE V. VALUES OF THE FUNCTION

$$y = 1 - \frac{4}{\pi}\left(10^{-x} - \frac{1}{3}10^{-9x} + \frac{1}{5}10^{-25x} - \ldots.\right) \text{ where } x = 0.434\frac{h^2\pi^2 t}{l^2}$$

x	y	x	y	x	y
0.01	0.0000	0.11	0.0546	0.36	0.4444
0.02	0.0000	0.12	0.0692	0.38	0.4693
0.03	0.0000	0.13	0.0848	0.40	0.4931
0.035	0.0001	0.14	0.1009	0.45	0.5482
0.04	0.0005	0.15	0.1176	0.50	0.5974
0.045	0.0010	0.16	0.1345	0.60	0.6802
0.05	0.0021	0.17	0.1517	0.70	0.7460
0.055	0.0037	0.18	0.1690	0.80	0.7982
0.06	0.0055	0.19	0.1862	0.90	0.8397
0.065	0.0081	0.20	0.2033	1.00	0.8727
0.07	0.0113	0.22	0.2372	1.25	0.9284
0.075	0.0150	0.24	0.2702	1.50	0.9597
0.08	0.0191	0.26	0.3022	1.75	0.9774
0.085	0.0241	1.28	0.3331	2.00	0.9873
0.09	0.0294	0.30	0.3727	2.50	0.9960
0.095	0.0351	0.32	0.3912	3.00	0.9987
0.10	0.0412	0.34	0.4184	3.50	0.9996
				4.00	0.9999

Examples—A dry spruce cross-tie 11.4x17.8 cm. (4½x7 in.) in section and 71 cm. (28 in.) long, and at an initial temperature of 15° C. (59° F.) is placed in an oven which heats its surface to 137° C. (278° F.) for 10½ hours. What should be the temperature at the end of this period for a point near the center of the tie?

As the heat penetration will be largely due to conduction across the smallest dimension of the tie we shall neglect the other faces altogether. We have then, effectively, a plate of thickness 11.4 cm. and diffusivity 0.00068 (pine wood in Table II), which gives $x = 0.85$. Then from Table V, $y = 0.82$, making a rise in temperature of 0.82 (137° − 15°), or 100°. This gives a final temperature of 115° C. (239° F.). In an actual experiment† this was found to be 113° C., checking our theory much more closely than could be expected, considering the approximations we have made in neglecting the other faces.

In the same way we can readily show by a few minutes' work with a sliderule that the center of a plate of steel 2.54 cm. (1 in.) thick, which is plunged into molten lead, should rise to within 2% of the temperature of its faces in less than half a minute; the center of a firebrick 6.3 cm. (2½ in.) thick, heated by flue gases in a regenerator, should show more than half its surface change in temperature in 10 minutes, and more than three-quar-

*For derivation see Ingersoll and Zobel, "loc. cit.," p. 105 ff.

†The writer is indebted to H. D. Tiemann, of the U. S. Forest Products Laboratory, Madison, Wis., for an account of this experiment.

ters in 20 minutes; a disk of glass 20.3 cm. (8 in.) thick, which has been subjected to a recent heating or cooling of a dozen degrees should be kept with faces at constant temperature for upwards of ten hours to insure that the interior temperature is uniform to a small fraction of a degree.

Theory of the Fireproof Wall

It may now be shown by very simple reasoning that the laws of heat penetration through a wall from a suddenly heated surface, can be deduced at once as a special case of the problem of the slab just discussed. If attention is fixed on the central point or plane of such a slab, both of whose faces are equally heated, it can be seen, from conditions of symmetry, that there is no more tendency for the heat to flow across this plane in one direction than in the other; in other words, there will be no flow of heat across such a plane. Then, without altering the conditions in any way, one can imagine a thin layer of some substance impervious to heat placed at this middle plane so as to divide the wall into two equal parts. Since these two parts are rendered in this way entirely thermally independent, one-half may be thought of as removed, leaving a wall heated on one side and protected on the other.

We may then conclude that the solution for the slab, heated on both faces, leads at once to that for a wall of *half* the thickness, whose front face is suddenly raised in temperature and whose rear face is protected from heat loss. The temperature rise of this rear face may be computed with the use of Table V, with the understanding, however, that l in that table is *twice* the actual thickness of the wall heated on one side.

Example—In one of Humphrey's experiments* at the Underwriter's Laboratory, an 8-in. (20.3-cm.) wall of stone concrete ("panel 19") at 23° C. had its front face heated for two hours at an average temperature of about 600° C. What should be the rise in temperature of the rear face, on the basis of our theory?

After shifting our temperature scale by the subtraction of 23°, to bring the initial temperature of the wall to zero, we may put $T_o = 577°$, $l = 40.6$, $t = 7200$ and $h^2 = 0.0058$ in Table V, and find at once that $T = 30°$; that is, the rise is 30° C., making a final temperature of 53° C. The temperature of the rear face as actually measured in this experiment was 56° C.

As a matter of fact this check must not be considered as quite so good as it appears, since the rear face of the wall in Humphrey's experiments was (apparently) not protected as assumed in our theory. However, by experimenting with miniature walls of porcelain heated by the application of hot mercury, the writer has checked the main theoretical conclusions with considerable accuracy.

Temperature Curves—The use of this theory in connection with such experiments as Humphrey's is now apparent; for it enables one to extend his results with some confidence, so far as they are concerned with the penetration of the heat wave, to a much wider range of temperature, time, thickness of wall and variety of material than would be possible without a vast amount of costly experimentation. An idea of such an extension is given in the curves of Figs. 1-3, where the temperature rise of the rear face is computed for walls of cinder and stone concrete and granite. Building brick would probably lie between cinder and stone concrete in this respect.

To illustrate further the use of the above tables in this connection we shall compute one point on these curves, namely, that for a granite wall 12 in. (30.5 cm.) thick, after four hours of heating. With $h^2 = 0.0155$, $t = 14{,}400$ and $l = 61$, the value of x comes out to be 0.26, which from Table V gives a temperature rise for the rear face of 0.30, that of the front face. Thus, if the front surface was heated 500° (C. or F.) above the initial temperature, the rear face should come to 150° above this temperature in four hours.

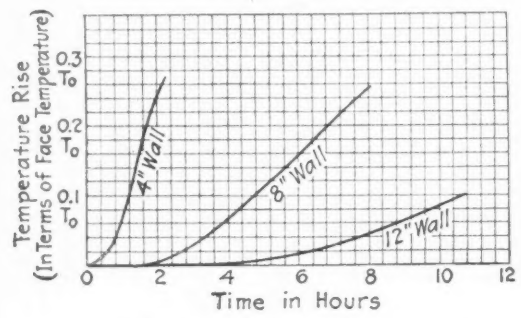


Fig. 1. Cinder Concrete
($h^2 = 0.0031$)

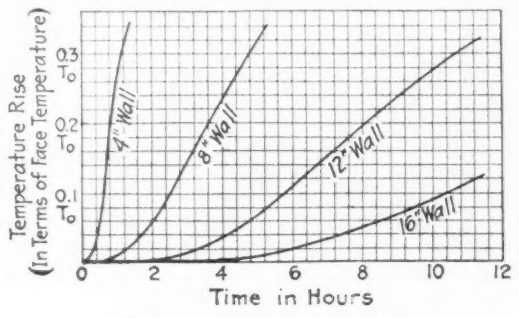


Fig. 2. Stone Concrete
($h^2 = 0.0058$)

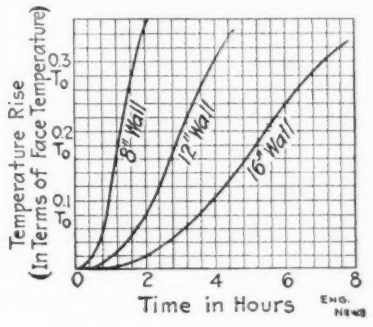


Fig. 3. Granite
($h^2 = 0.0155$)

Figs. 1, 2 and 3. Computed curves showing temperature rise of rear faces of walls with front faces suddenly heated to and maintained at given temperature T_o.

Limitations—In making such computations it must be remembered that they apply primarily only to a wall or floor so protected by casings, furniture or piles of (combustible) material that the heat transmitted through the wall has small chance to escape. In an unprotected wall, allowing free radiation and convection, the temperature rise should not be quite so high, so that the use of these laws would allow a small "factor of safety" in design. However, as a particular instance of a case in which they would not apply at all, may be cited the covering on an iron pillar or post which is sometimes designed for fire protection. Despite the rapidity of heating, the transfer of heat from the front to the rear surface of such a (thin) covering would be essentially a case of "steady state" and the corresponding simple equation would apply. The amount of heat conveyed to the post and its temperature rise would be in this case an approximately linear function of the time and reciprocal of the thickness of covering, and dependent directly on the conductivity of the latter rather than on its diffusivity.

There are, in addition, one or two other factors occurring in actual practice which would cause deviations from these theoretical predictions. The first is the crack-

*R. L. Humphrey, U. S. Geological Survey Bulletin, No. 370.

ing which frequently accompanies such rapid heating, allowing a more rapid penetration of the heat wave, and the second is the fact that in no case will the heating of the front surface be instantaneous as assumed here. While it is evidently impossible to take account of the first factor theoretically, the second has been considered and it is found that the preceding treatment should hold in any case in which the heating is moderately rapid, provided the average temperature is used.

Another consideration which will be recognized at once as of fundamental importance in some cases, e.g., the fireproof vault, is the *maximum* temperature which will be reached by the rear face of such a wall if the heating of the front face is discontinued after a given time. As this varies so largely with circumstances, such as whether the face of the wall is quenched or simply allowed to cool, the treatment is necessarily somewhat complicated and will not be taken up here.

General Conclusions—It is evident from an inspection of the equation preceding Table V, that the law connecting time with the square of distance of penetration has the same validity for walls as for the case previously considered. This appears at once in the curves of Figs. 1-3, where it is apparent that doubling the thickness of the wall will cause a four-fold delay in the time required for the penetration of any given temperature.

This fact may be worth noting in connection with fireproofing design, but undoubtedly the most important conclusion to be drawn from this whole discussion is the fact that it is the thermal *diffusivity* rather than the conductivity alone, which controls the penetration of the heat wave under conditions such as these. In cases where these principles are involved, a high density and high specific heat, as well as a low conductivity, should be sought for in the materials of construction.*

⁂

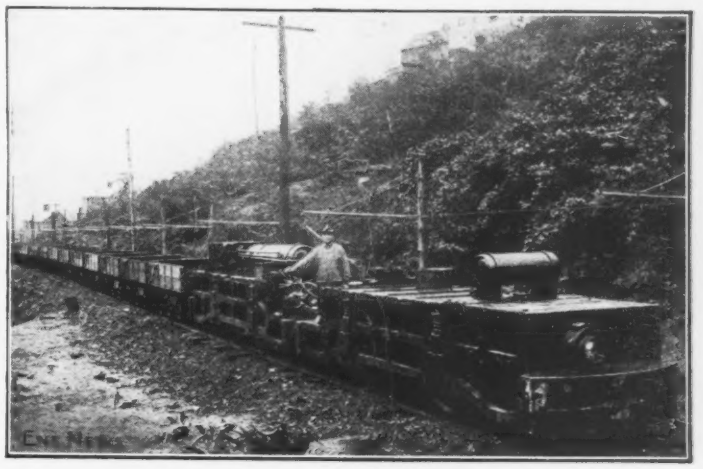
A 30-Ton Electric Mining Locomotive

Two 30-ton electric locomotives of the Baldwin-Westinghouse "bar-steel" type were recently installed at the Charleroi, Penn., coal mine of the Carnegie Coal Co. Each locomotive consists of two 15-ton units, which can be used as separate locomotives if desired. The distribution of the 30-ton weight over eight wheels gives large tractive power with a moderate load per wheel.

The illustration shows the meaning of "bar-steel" construction. The locomotive side frames are formed as a grid of heavy steel bars; each side frame is a single steel casting giving a strong and rigid construction. The openings in the frame allow ready access for inspecting, oiling, replacing brake-shoes, etc., and also provide excellent ventilation to the electric equipment.

The locomotive is equipped with air brakes and each unit is equipped with hand brakes which can be operated together from the operating stand of the leading unit. On this same unit the main air reservoir and air compressor for the brakes are located, while an auxiliary air reservoir is provided on the trailing unit.

For track gages up to 36 in., 51-hp. motors are used. For a track gage of 36 in. or above, 84-hp. motors may be used if the service demands them. Each unit is equipped with two Westinghouse commutating-pole, railway-type motors. The controller for the tandem is of the individual magnetic-blowout type, and handles the four motors simultaneously. When the tandem is split, the four-



The Tandem Electric Locomotive in Operation

motor controller operates the two motors of this unit without change in connections, while the other unit has its own two-motor controller.

⁂

The Automobile Manufactories of Detroit, Mich., have a total annual capacity of 400,000 automobiles, are capitalized at over $100,000,000, and employ 120,000 people, the weekly pay roll being over $1,500,000. The total value of automobiles and automobile supplies produced by Detroit this year, exceeds $650,000,000.

The Stresses in a Reinforced-Concrete Floor Slab under heavy load are being determined at the new freight terminal of the Minneapolis, St. Paul & Sault Ste. Marie Ry. in Chicago. This terminal has the tracks and team driveways on a concrete floor of great area, supported by columns, the space beneath being utilized for storage, as described in detail in our issue of Aug. 21. The tests and measurements are being made over an area of four panels, each 24x24 ft. c. to c. of columns, the load on each panel being 400,000 lb. The concrete was almost 3½ months old at the time of testing.

The test load consists of eight steel hopper-bottom ore cars 25 ft. long, and about 21 ft. 6 in. c. to c. of trucks. The height of the sides is increased by planking, and each car is loaded with broken stone so as to give a total load of 205,000 lb. on the wheels. The load gives a concentration in excess of that due to locomotives of Cooper's E-50 loading, for which the structure was designed. The cars stand on four ordinary tracks (12 ft. c. to c.), laid on a bed of stone ballast on the concrete floor. After measurements of stress and of bending, deflection, etc., had been made with the cars in position, the cars were removed and measurements made to determine the recovery of the structure. The cars were then replaced, but shifted half a panel length from the original position, and measurements again taken.

After the tests on this area, the cars (with two additional cars similarly loaded) were transferred to a track laid on the slab midway between two lines of columns, and observations made to determine any troughing of the slab under this load.

The tests are made with extensometers and micrometer strain gages, noting the distances between marked points on the slabs and columns, and the instruments are checked frequently by comparison with a standard bar. More than 800 gage lines were measured. Considerable preliminary work was required in cutting away the concrete to expose the reinforcing bars and in setting the measuring points. The testing is being done by the Engineering Experiment Station of the University of Illinois, under the direction of Prof. A. N. Talbot, and Arthur R. Lord, consulting engineer, is coöperating in the work. The readings are made by members of the staff of the Experiment Station, trained in this line of work, and there are five observers and five recorders on the work. The working out of the results will take some little time.

*I. H. Woolson (Proc. Am. Soc. for Testing Materials, Vol. 6, p. 438, 1906) notes that in one test, cinder concrete gave hardly better insulation tests than gravel concrete. If the cinder concrete was of low density the explanation is probably that suggested above.

The Industrial City of Torrance, California

By Ralph Bennett*

SYNOPSIS—There has just been completed near Los Angeles, Calif., the first unit of an industrial city, which is the first of its kind on the Pacific Coast. The general layout of the city and its various public improvements are here described.

❖

The growth of southern California has been very rapid in recent years. The number and size of the manufactories have also increased and land for industrial purposes in Los Angeles has become very expensive. The industrial districts are limited by ordinance, and large tracts of land suitable for factory use can be had only with great difficulty.

This situation became so acute that about two years ago a number of important manufactories in the vicinity agreed to remove their plants to a common, suburban, industrial city, if a satisfactory location could be found.

For such a town there is required a location with good drainage, gentle slopes and good soil; good transportation both by rail and road. About 23 miles south of Los Angeles is San Pedro, its principal harbor; at about an equal distance southwest in Redondo, a port of some importance. The land in the immediate vicinity of the harbors is too valuable to permit of the construction of a residential, manufacturing town directly upon tidewater. But between the city and these ports lies the Dominguez Rancho, a rolling stretch of farming land, which contains an excess of 20,000 acres. Of this, 3500 acres was purchased and arrangements were made with the Southern Pacific and the Pacific Electric Ry., by which Torrance would become a terminal point, and would have proportionate rates for local short hauls. Further arrangements were made by which one system of freight spur and industrial tracks would be operated by the Pacific Electric Railroad, as a terminal road for all other freight-carrying concerns.

There were assured to the town of Torrance three important shops: the Union Tool Co., employing a minimum of 400 men; the Llewellyn Iron Works, employing a minimum of 600 men; and the Pacific Electric Railway Co.'s car-building shops, which will eventually have a minimum of 1500 men. It was thought that this extensive concentration of metal-working firms would undoubtedly bring additional smaller firms in the same lines and also a general line of factories. The situation warranted a first-class development.

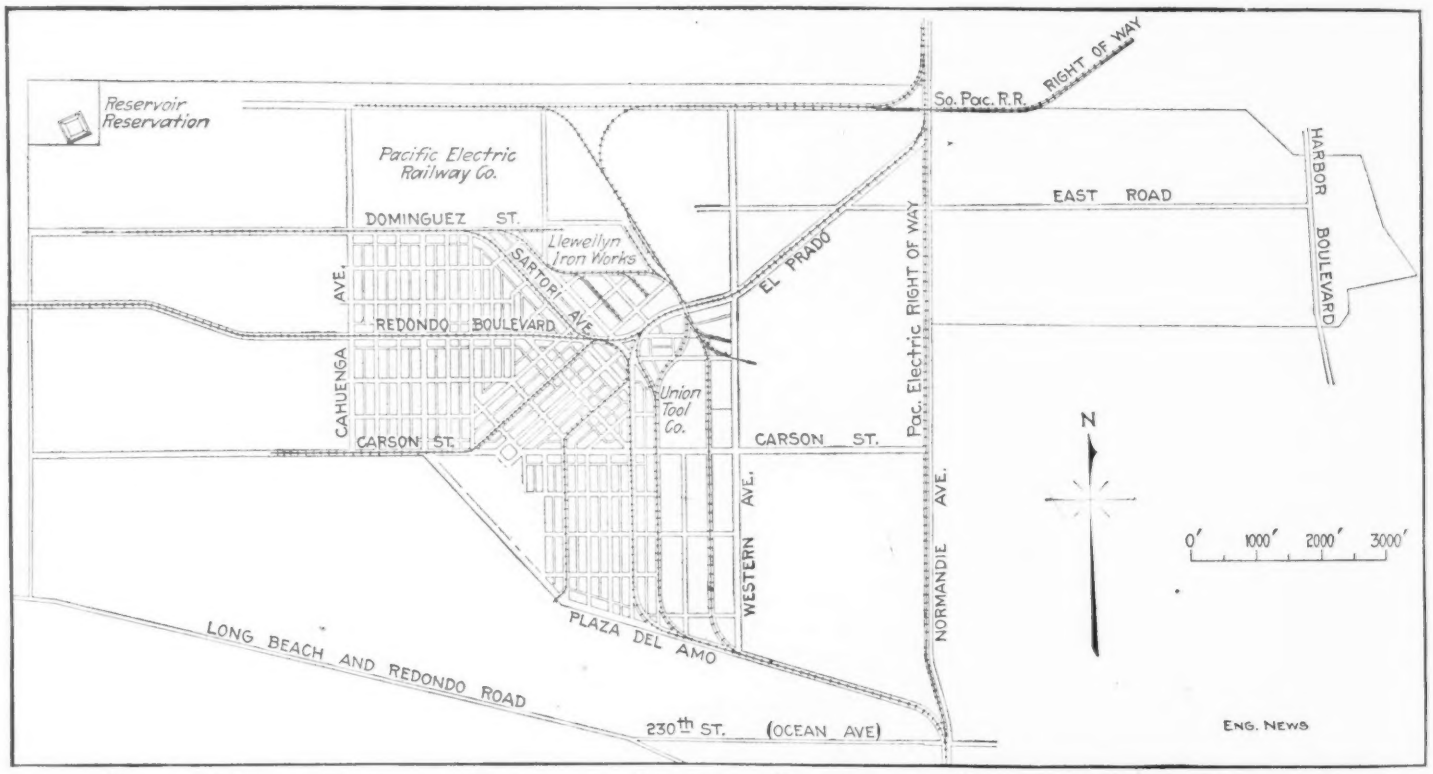


Fig. 1. Map of Torrance, Calif., and Adjacent Property of Dominguez Land Corporation

General Street Plan—In an industrial community, it is important that transportation should be easy and rapid; that the factory districts should be separated from the business and residential districts, and that ample growth should be provided for both without involving future intermingling.

The first unit of the new city (Fig. 1) was placed approximately in the center of the main holding of the company, so that factory growth could occur in one section, while the residential growth took place in the other. From this general scheme there was developed a street plan fitted closely to the topography of the ground. Continuous and rectilineal streets were adopted, where transportation conditions would permit, because they permitted of simpler and less expensive utility work. In a residential town for manufacturers' employees, the consideration of beauty of line is less important than good cheap living conditions.

*Consulting Engineer, 625 S. Hill St., Los Angeles, Calif.

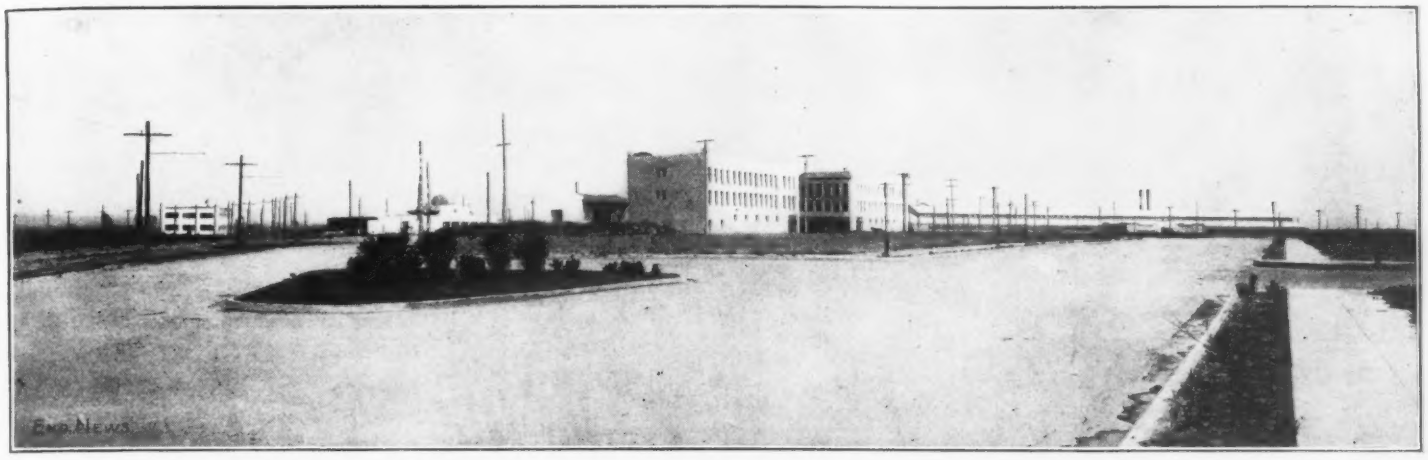


FIG. 2. SMALL PARKING AT DIAGONAL STREET INTERSECTIONS, TORRANCE, CALIF.
(The view also shows the general character of the pavement, curbs and sidewalks.)

The general street plan adopted places the factories on two sides of a rectangle, with the business section as a fringe between this factory district and the residential section which covers the remainder of the rectangle (Fig. 1). This results in a city in which any residence district can be approached from any factory district without serious detours, and in which some portion of the business district is traversed by all such travel. The diagonal intersections and the easy railway curves result in a considerable variation in the effect of the streets, and give opportunity for many small parkings (Fig. 2). The general scheme of street-block arrangement or street cross-section is shown by Fig. 3.

Topography permitted the separation of grades between freight and passenger tracks at the only point in which a crossing occurred within the boundaries of the property. The scheme for the city includes a proper provision of parking, of civic center space and of school and playground facilities. The area developed so far has been brought to a finished grade, paved with permanent work and sewered.

PAVEMENTS—In the business section of the town the streets are from 80 to 108 ft. wide. This area is paved with two-coat asphaltic concrete. The base is an asphalt-gravel mixture 4 in. thick. The top is an asphalt-sand mixture 1 in. thick. On the secondary business streets, on the connecting boulevards, and on some residence streets, the pavement is a water-bound, oil-surfaced macadam.

On the standard boulevards the center depth of the

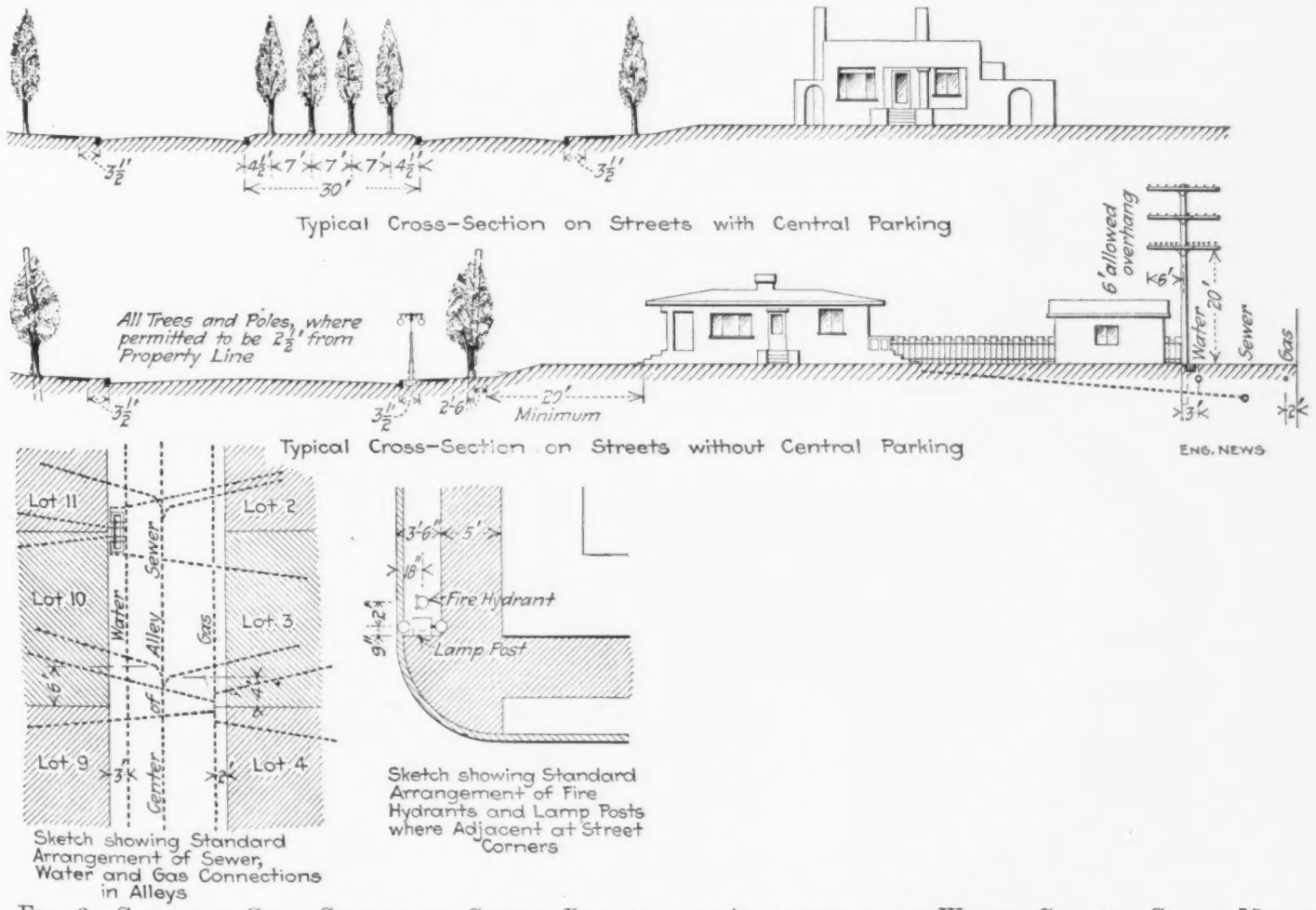


FIG. 3. STANDARD CROSS-SECTION OF STREET BLOCKS AND ARRANGEMENT OF WATER, GAS AND SEWER MAINS AND CONNECTIONS, FIRE HYDRANTS AND LAMP POSTS, TORRANCE, CALIF.

FIG. 4. FIRE HYDRANT AND LAMP POST, TORRANCE, CALIF.

pavement is 5 in., which shades off to a 2-in. depth at the edge of the pavement, or at the curb if placed on a curbed street.

The asphalt specification is as follows:

(A) ASPHALT CONCRETE BASE—Upon the roadbed prepared and brought to sub-grade, there shall be constructed a 4-in. asphalt concrete base consisting of the materials and prepared in the manner hereinafter provided and which asphalt concrete shall be composed of broken stone (or screened gravel as hereinafter provided), sand and asphaltic cement. The asphalt concrete may be prepared by mixing the several classes of materials in proper proportions or by the combination of natural asphaltic materials with the individual ingredients so as to produce the required mixture. The percentage composition, by weight, of the asphalt concrete base shall be within the following specified limits:

Broken stone, between 60 and 70%.
Sand, between 25 and 35%.
Asphaltic cement, between 5 and 8%.

Provided, however, that in lieu of the broken stone, the contractor, at his election, may use screened gravel, in which the largest particles shall not exceed 2½ in. in their greatest dimension, and all of which shall be retained on a ¼-in. mesh screen and in which not less than 40% shall be retained on a 1¼-in. mesh screen and not less than 20% shall be retained on a ½-in. mesh screen.

(B) ASPHALTIC WEARING SURFACE—Upon the asphalt concrete base prepared and laid, and after it has been thoroughly swept free from all dirt and rubbish, shall be laid a 1-in. asphaltic wearing surface, consisting of the materials and prepared in the manner hereinafter provided, and which asphaltic wearing surface shall be composed of sand, stone-dust and asphaltic cement, the different ingredients being mixed in such proportions that the percentage composition by weight of the wearing surface shall be within the specified limits as follows:

Sand, between 65 and 86%.
Stone-dust, between 5 and 18%.
Asphaltic cement, between 9 and 17%.

The asphaltic wearing surface may be prepared from individual ingredients or by a combination of individual and natural asphaltic mixture, as hereinbefore described for the asphaltic concrete base.

The residence streets are usually 60 ft. wide. Provision has occasionally been made for a wide center-parked street. Future car-lines have been provided for by wide streets. Secondary cross-streets are located at intervals of 500 to 600 ft. Provision has been made throughout for 20-ft. alleys, in which all utilities are located. Each utility is given a specific location for its mains and for its service runs (Fig. 3).

CURBS AND SIDEWALKS have been carried throughout the business and residential section and into portions of the factory district. Residential curbs are 5x9x16 in.; business curbs 6x10x16 in. Curb-return radii in the first part of the work were 8 ft., but the newer work was installed with a 15-ft. radius, which appears to be materially better.

Street names are stamped into curbs and sidewalks with letters 3½ in. high and ⅜-in. deep.

WATER-SUPPLY—The domestic water-service network presents no unusual constructional features. It is made up entirely of Class "B" cast-iron pipe. All service runs are located in the alleys. The minimum pipe is 4 in. in diameter. These runs are tied together by cross-headers

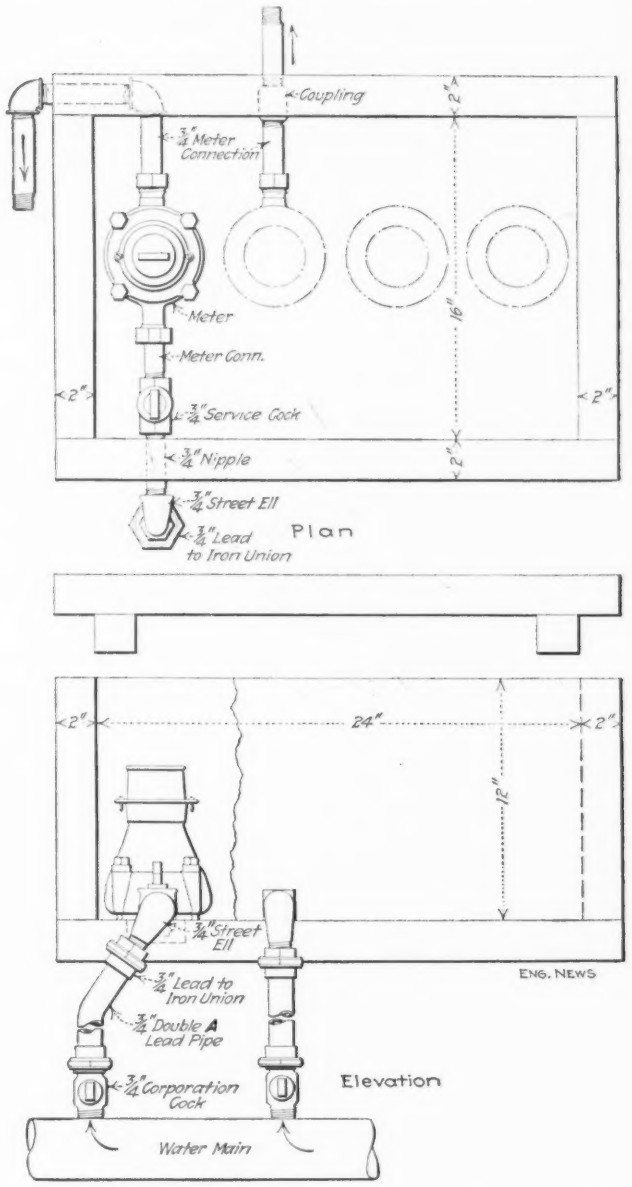


FIG. 5. CLUSTER OF WATER METERS IN BOX IN ALLEYS AND CONNECTIONS WITH WATER MAIN, TORRANCE, CALIF.

of larger pipe. The entire network is divided into small sections by means of valves.

Except on a few cottage streets, fire hydrants are installed at intervals of less than 600 ft., but fall on street or alley and street intersections. There are no hydrants on dead ends. All hydrants have a 6-in. wrought-iron post and a cast-iron head, containing one 2½-in. and one 4-in. outlet (see view, Fig. 4). The valves are located in the head. They have lead-faced disks, closing against bronze seats.

All water is metered. Water taps are made with ¾-in. Mueller type corporation cocks and 18-in. lead connection pipes. Meters for four adjacent lots are set in a common box and piped to their respective lots on the shortest run (see Figs. 3 and 5).

The network has been designed on the basis of a population of 25 people to the acre, with a per capita consumption of 150 gal. a day, of which 120 gal. is used in 10 hr., or on the supply of two 250-gal. fire streams from any single hydrant.

Water is sold on a sliding scale as follows:

0-1999 cu.ft. per month,	10c. per 100 cu.ft.
2000-3999 cu.ft. per month,	9c. per 100 cu.ft.
4000-5999 cu.ft. per month,	8c. per 100 cu.ft.
6000-7999 cu.ft. per month,	7c. per 100 cu.ft.
8000-9999 cu.ft. per month,	6c. per 100 cu.ft.
10,000 and over,	5c. per 100 cu.ft.
Farm irrigation water,	3c. per 100 cu.ft.

At the present time water is purchased from the Dominguez Water Co., which pumps from wells located about five miles east of the town. This is an especially pure water. An auxiliary supply from deep local wells has been considered desirable and will probably be installed at some future date.

The pressure in the water mains is regulated by means of a 24,000,000-gal. storage reservoir at the west end of the property. This gives about 20 lb. through most of the tract. A motor-driven turbine pump brings this up to 50 lb. for fire service. When the town has developed to a larger size, pressure from this booster pump will be made continuous and a 100,000-gal. water tower installed to act in conjunction with it. At the same time there will be installed a 1000-gal., 100-lb. fire pump, which will be used until such time as the property warrants the purchase of an automobile fire engine.

Sanitary Sewers—The property is covered by a complete sanitary-sewer system, practically all of which is vitrified tile, although there is one section of 18-in. wet-mixed and glazed-concrete pipe, and a 12-in. reinforced-concrete force main for the treated effluent.

Sewage Treatment—Sewage is delivered by gravity to a reinforced-concrete Imhoff tank, 24 ft. in diameter and 27 ft. deep, designed to serve 2500 people on the basis of 75 gal. flow per day. A float-controlled, electrically driven pump lifts the tank effluent 40 ft. and delivers it to a sewage farm, 7000 ft. distant. Space has been reserved at the site of the present tank for additional tanks and also for trickling or percolating filters.

Surface Drainage—In southern California, the rains are torrential in character and infrequent in number. Gutters usually contain much débris at the time when the storms come, resulting in serious clogging of storm-drain entrances. In laying out Torrance, storm drains have been avoided where possible and where undercrossings were essential, provision has been made to permit excess flow to pass over the top of the pavement in the same general direction as the underflow. These crossings (Fig. 6) are practically all corrugated-iron arcs resting upon heavy reinforced-concrete bases, as it was found that the use of heavy motor trucks tended to crush down corrugated tops placed on plain concrete bases.

The Telephone and Lighting Systems are on overhead construction except that in the main business district undercrossings are made in iron conduit. Street lights are carried on posts placed 300 to 600 ft. apart in the residence district and 150 ft. apart in the business district. Part of the lights run until 10 p.m.; part all

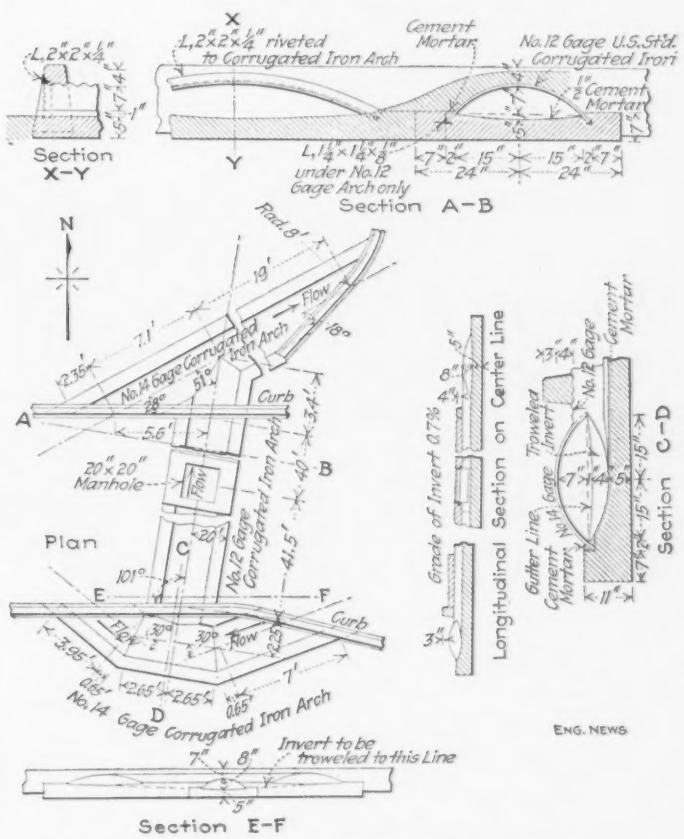


Fig. 6. Surface Drainage Details at Street Crossings, Torrance, Calif.

night. The leads are brought to the posts by iron-pipe conduits placed in the street parkings. These conduits are run to the alleys where connection is made with the lighting company's overhead system. The posts are wrought iron. Each carries two 100-watt tungsten lamps.

Buildings—Considerable attention was given to the building work of the town. The company has restricted the business section to high-grade work. No wooden stores are permitted.

A number of fireproof cottages were also built, but the need of immediate housing accommodations limited the work along this line. The ten cottages built are double-plastered, without air space in the walls; they have concrete floors and flush metal door and window frames. The exteriors are severely plain and present a great contrast to the ordinary Los Angeles bungalows.

The Dominguez Land Corporation, which owns and developed the property, is a syndicate of local capitalists headed by the Torrance Marshall Co. The active organization was under the control of H. H. Sinclair, vice-president and general manager; Ralph Bennett, chief engineer; and I. J. Gill, architect. Bent & Pennybaker, were general contractors on both paving and sewer systems. Robt. Sherer & Co. had the grading contract. The water system was installed by the company's forces.

Fred Harris Daniels

The death of Fred H. Daniels, of Worcester, Mass., one of the most active and distinguished mechanical engineers of America, was briefly noted in our issue of Sept. 11. For the improvements he devised in the steel and wire-making industry he had long had an international reputation. He was Chairman of the Board of Engineers of the United States Steel Corporation, a member of its board of engineers which planned and built the Gary, Ind., and Duluth, Minn., plants, and Chief Engineer of the American Steel & Wire Co. In 40 years he had taken out more than 150 patents relating to the manufacture of steel rods and wire, and he was awarded the grand prize and gold medal of the Paris International Exposition in 1900, for achievements in the development of the wire industry. In 1910 he was honored with the title of Knight of the Royal Order of the North Star, first class, by King Gustaf, of Sweden.

F. H. Daniels

Fred Harris Daniels was born June 16, 1853, at Hanover Center, N. H. He was of New England ancestry and the youngest of four brothers, one of whom, Charles Herbert Daniels, has achieved distinction as a clergyman and foreign missionary; the two others were both killed in battle during the Civil War.

Mr. Daniels graduated from the Worcester Polytechnic Institute in 1873, in the third class to leave that institution, and was a classmate of John W. Kendrick, until recently Vice-President of the Atchison, Topeka & Santa Fé Ry., and formerly Chief Engineer of the Northern Pacific Ry. At the Institute he was distinguished as a student and his graduating thesis on compound engines has always been considered a model for student work. Following his school work he at once entered the employ of the Washburn & Moen Manufacturing Co., of Worcester, makers of steel rods and wire.

From the very beginning of his practical engineering experience almost his entire attention was given to the solution of problems connected with this industry. His first position was as a draftsman in the office of the late Charles H. Morgan, then General Superintendent of the Washburn & Moen Manufacturing Co. Mr. Morgan was at that time engaged in taking down a Siemens regenerative furnace, used in connection with the Bedson continuous mill, which had been constructed some time before from English drawings. Mr. Morgan had some substantial improvements to introduce and to young Mr. Daniels was intrusted the preparation of the detail plans. The new furnace proved a great success and the improvements were patented by Mr. Morgan and Mr. Daniels, and resulted in great profit to the company.

During the hard times of 1873 and 1874, after a vacation in Florida, necessitated by his previous hard work, Mr. Daniels was unable to find employment as a draftsman, so he entered the company's machine shop and here obtained some practical experience which ultimately proved of infinite value to him, as an engineer and manufacturer. In 1874, the wire business underwent an extraordinary development and Mr. Daniels returned to his former position as engineering assistant to Mr. Morgan.

It was soon after decided essential to establish a chemical laboratory in connection with the company's works. Mr. Daniels was accordingly sent by his company to interview Dr. Thomas M. Drown, of Lafayette University, a great authority at that time on the metallurgy of iron and steel. The result of this interview was that Mr. Daniels accepted a position as Dr. Drown's assistant at Easton, Penn., while at the same time continuing his work for the Washburn & Moen Manufacturing Co.; and while here in the heart of the Pennsylvania iron and steel country, he gained an intimate knowledge of steel making which was to stand him in good stead. Upon his return to Worcester he was made Mechanical and Chemical Engineer of the company and was given charge of the designing department and the laboratory.

In 1877, the Washburn & Moen Manufacturing Co. sent Mr. Morgan and Mr. Daniels to Europe for the express purpose of familiarizing themselves with European practice and progress. The tour included England, Norway, Sweden, Germany, Belgium and France. In Sweden, Mr. Daniels was so impressed with the results accomplished by openhearth steel works and rod mills that he stayed for some months at one of the largest plants as a common workman. Returning to Worcester he installed 16 Lancashire openhearth furnaces and as a result the Washburn & Moen Co. became one of the largest manufacturers of charcoal iron in the United States. This was but the first of several European trips made by Mr. Daniels in the interest of his company.

From that time on, Mr. Daniels' development and success kept pace with the expansion of the steel-wire industry. He became General Superintendent and Chief Engineer of the Washburn & Moen Co., and later Chief Engineer of the American Steel & Wire Co., when it absorbed the Washburn & Moen Co. When the United States Steel Corporation acquired the American Steel &

Wire Co., Mr. Daniels became the practical mechanical engineering head of this whole great corporation.

In recent years Mr. Daniels' business had frequently taken him from one end of the country to the other, and he was thus personally acquainted with a great many engineers in the iron and steel industry. He was a member and former Vice-President of the American Society of Mechanical Engineers, a member of the American Institute of Mining Engineers, of the American Society for Testing Materials, the Iron and Steel Institute of Great Britain and the American Iron and Steel Institute. He was a member of the Century Club, of Cleveland, Ohio, the Engineers and the Machinery Clubs, of New York City, the Duquesne Club, of Pittsburgh, Penn., and several Worcester organizations.

However, with all his business activity, he had always found no little time to devote to the welfare of Worcester and its institutions. He was a trustee of the Worcester Polytechnic Institute and Chairman of its Shop Committee; he was a member of the Street Congestion Commission, of Worcester, and a director of the Massachusetts Employees Insurance Association. He was also a director in several of local industrial corporations.

Mr. Daniels was married in 1883, to Miss Sarah L. White, of Worcester, who with three sons survives him.

Separate and Combined Sewers in Relation to Sewage Disposal*

By John H. Gregory†

One of the most important factors in the choice between the separate and combined system of sewerage is what is to be done with the sewage after it has reached the sewers. If the sewage is to be discharged into a body of water without any treatment whatsoever, a condition less and less likely to arise in the future, combined sewers would frequently offer the simplest and cheapest solution of the problem. If, however, the sewage is to be treated, separate sewers have certain advantages. In order to limit somewhat the scope of the paper it will be assumed that the sewage must receive some treatment before final discharge and that the treatment will be at one point. Further, that ample opportunity is afforded for the discharge of storm water without having to carry it any great distance.

Sewage treatment works cost money. It is therefore desirable to keep them as small as possible, and in order to do this the volume of liquid to be handled must be kept at a minimum. Rarely, if ever, would it be the case that all of the storm water would have to be treated; hence in this discussion the question of treating other than the first wash of the streets, in addition to the sewage, will not be considered.

With a separate system the volume to be handled at the treatment works is the total sewage flow in the sanitary sewers. The liquid is made up of house sewage, ground-water leakage and trade wastes. The flow may, however, be increased in times of storm by taking in the first wash of the streets from the storm-water drains should it be found necessary or desirable to treat the first wash.

With a combined system, under dry-weather conditions, the volume to be handled ordinarily is what is commonly spoken of as the dry-weather flow and is also made up of house sewage, ground-water leakage and trade wastes. In times of storm, however, the flow in the combined sewers is increased by the storm water from the streets. The liquid then consists of a mixture of house sewage, ground-water leakage, trade wastes and storm water.

The effect of the storm water in combined sewers is twofold—it not only increases the volume of liquid flowing but it changes its character. The first wash from the streets is often exceedingly foul and may increase the organic content of the liquid flowing in the sewers, giving what may be called a stronger sewage. As more and more storm water enters the sewers the storm water becomes cleaner and cleaner and with the greatly increased flow in the sewers the organic content of the liquid is decreased, resulting in what may be called a weak or dilute sewage.

The volume of liquid to be handled at the treatment works from a combined system depends on whether only the dry-weather flow or the dry-weather flow plus some storm water is to be intercepted. If only the dry-weather flow is to be intercepted then the volume to be handled at the treatment works would, in general, be substantially the same from the combined system as from the separate system.

One fundamental difference between the two systems, however, exists. With the separate system no raw sewage escapes to the streams or water courses, while with the combined system raw sewage must at times be discharged into them. If it is planned to intercept only the dry-weather flow, then, during storms, just as soon as the flow in the combined sewers exceeds the maximum rate of dry-weather flow, the surplus flow over and above that which can be intercepted, escapes, with the result that a mixture of sewage and storm water must reach the streams.

It is true that the overflow of raw sewage from combined sewers into the streams ordinarily would take place only during periods of storm, but even the occasional discharge of raw unscreened sewage into a stream is a question which must be carefully considered. It might be the case, and probably often would be the case, that as far as the temporary reduction of dissolved oxygen in the stream is concerned no harm would be done, but floating particles of paper and fæcal matter are offensive to the sight. If, however, the stream into which the overflow of sewage would take place is sluggish and with but little velocity it may easily be that the continued overflow of sewage into it, from time to time, with the accumulation of sludge deposits on the bottom, would lead to offensive conditions.

With a combined system, in order to reduce the number of times during the year that raw sewage would overflow, it might be planned to intercept some storm water as well as the dry-weather flow. One direct effect which this would have on the sewage-treatment works would be to increase their size, and consequently their cost, over and above that which would be required if the separate system had been adopted.

If it is found desirable or necessary to intercept and treat the first wash from the streets the separate system is more advantageous than the combined system as by its adoption no overflow of raw sewage to the streams will take place. The storm-water drains receive only storm water and the first wash from the streets can be intercepted in the storm-water drains and discharged either into the sanitary sewers, or into the intercepting sewer leading to the treatment works. As the flow in the storm-water drains increases, the surplus water, over and above that intercepted, overflows to the streams but carries no sewage with it.

The separate system, under certain conditions, offers greater flexibility in the disposal of trade wastes than does the combined system, unless the first wash of the streets is to be intercepted and treated. Some trade wastes are offensive and if discharged into the sewers in such a condition must be treated. On the other hand some trade wastes are inoffensive and can be discharged direct into the streams without causing any nuisance or trouble.

With the separate system the offensive trade wastes can be discharged into the sanitary sewers and the inoffensive wastes into the storm-water drains. The offensive trade wastes only would then be carried to the treatment works. With the combined system all of the trade wastes, the inoffensive as well as the offensive ones, would have to be intercepted and carried to the treatment works, with the result that the treatment works would have to be somewhat larger in size, and hence would cost more, than would be the case if the separate system had been adopted.

With a community which is largely residential in character, the volume of trade wastes would affect but very little the total sewage flow. With a manufacturing community, however, the trade wastes might amount to quite a large percentage of the total flow and in extreme cases might equal in volume the house sewage. Under such conditions it is evident that, if any considerable percentage of the trade wastes is offensive, separate sewers would be of decided advantage as they would permit of the inoffensive wastes being discharged direct into the storm water drains, the offensive wastes only being discharged into the sanitary sewers and by them carried to the treatment works.

With a combined system, automatic regulators are generally used on the connections between the combined sewers and the intercepting sewer to limit the amount of flow from the combined sewers to the intercepting sewer. With a separate system automatic regulators are not required unless

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the first wash from the streets is intercepted in the storm-water drains. Automatic devices in sewers, as a general proposition, no matter how well designed, are to be avoided wherever possible.

The presence of grit at a sewage-disposal works is generally more or less of an annoyance, especially when the sewage has to be pumped and passed through settling tanks. With combined sewers, receiving as they do storm water from the streets, a considerable amount of grit must be expected to reach the disposal works, not only during wet weather but during dry weather also. With separate sewers the amount of grit received at the disposal works is relatively small unless the first wash from the streets is intercepted in the storm-water drains and carried to the disposal works.

With combined sewers or with separate sewers in which the first wash from the streets is intercepted in the storm-water drains, grit must be expected. Such being the case, it is a question if the simplest way of handling the grit is not to admit it into the intercepting sewer from the combined sewers to storm-water drains, without attempting to intercept any portion of it, and then to transport it with a good velocity in the intercepting sewer direct to the sewage-disposal works. Even with sand catchers on the connections between the combined sewers or storm-water drains and the intercepting sewer, enough grit is sure to reach the sewage-disposal works to require its removal before the sewage is pumped or passed through settling tanks. The removal of grit at one point instead of at numerous points has many advantages.

With a separate system, in which the first wash from the streets is not intercepted from the storm-water drains, a question arises as to the necessity of providing a grit chamber at the sewage-disposal works. Practice varies. At some disposal works grit chambers have been provided and at others not. If the sanitary sewers are properly designed and built and are provided with tight covers, very little grit should get into the systems; but with macadam or dirt streets and perforated covers some grit must be expected. The safest plan, under ordinary conditions, seems to be to provide a grit chamber, even it be a small one. The grit would require removal only at more or less infrequent intervals.

If the grit is admitted to the settling tanks it may cause trouble there. It depends, of course, on what type of tank is used and on the method of operation. If the tank is an Imhoff tank, the grit, by settling down into the sludge digestion chamber, may check or prevent the proper digestion of the sludge and consequently affect the satisfactory operation of the tank. The admission of grit to a septic tank also may interfere with its satisfactory operation. If admitted to a plain settling tank, which is cleaned out at frequent intervals, the main trouble to be expected would be in the cleaning out of the tank.

With sewage from a combined system, the volume of sludge accumulating in settling tanks is greater than with sewage from the separate system. It may even be nearly twice as much, as has been found to be the case by comparison of the quantities of digested sludge removed from different Imhoff tanks, some of which have been connected with combined systems and others with separate systems. The greater volume of sludge from the combined system may mean that less organic matter has reached the streams than would have been the case if the sewers had been built on the separate system. If, however, the first wash from the storm-water drains of a separate system is intercepted and carried to the treatment works then the volume of sludge should be approximately the same as if the sewage came from a combined system. Similarly the amount of organic matter reaching the streams should be approximately the same, although it is possible that it might then be somewhat less.

In many instances, probably in the majority of cases, pumping is required in order to pass sewage through a treatment works. This is generally due to the fact that the site of the treatment works is more or less distant from the territory sewered and by the time the sewage has reached the treatment works enough head has been lost to prevent passing the sewage through the works by gravity. It may even be that the sewage would be delivered at an elevation below that of the stream into which the effluent was to be discharged.

With a combined system the total height to which the sewage would have to be pumped would probably be somewhat less than with a separate system, but the difference would not be great. Some saving in fuel might therefore result from the adoption of the combined system but the same operating force would be required in either case. So long as pumping is required the actual saving in cost due to pumping the sewage against a less head, due to the adoption of the combined system, would be slight compared with the total cost of pumping, including fixed charges.

In conclusion, no hard or fast rules can be given for the adoption of either the combined or the separate system. Each has certain advantages. These, as well as local conditions and cost of construction and operation, must be taken into account. Other things being equal, especially as more and more attention is being given to the question of sewage disposal, the separate system seems to offer greater advantages. With either system, however, to secure satisfactory results too much stress cannot be laid on the necessity of not only proper design but satisfactory maintenance and operation.

Rail Failures in 1912

The Rail Committee of the American Railway Engineering Association publishes its statistics and discussion of rail failures for the year ending Oct. 31, 1912, in the Association's bulletin, July, 1913. The statistics are brought together in a large number of tables and diagrams, without definite conclusions.

The statistics cover 182,000 miles of railway, with 14,132,982 tons of rail (10,156,935 bessemer, 3,580,021 openhearth, 396,026 tons special steel or special sections).

There are reports of 26,122 rail breakages. This is about one in 7 mi., for the year.

From the committee's conclusion we quote the following:

> The wide variation in results must be due to a large extent to a lack of uniformity in the performance of different mills and also to a lack of uniformity in the product of any individual mill.
>
> The average performance of the heavy sections (85 lb. to 100 lb.) is not so good as that of the lighter sections (72 lb. to 80-lb.). The average rate of failure of the openhearth rail is lower than that of the bessemer, though both are higher than last year. The thought expressed in last year's report that possibly as its age increases the rate of failure of the openhearth rail will increase so as to approach that of the bessemer rail is not corroborated by this year's figures. The rate of failure of the bessemer rail was, in 1912, 116% higher than that of the openhearth; in 1911, 58% higher than that of the openhearth; in 1910, 94% higher.
>
> A higher percentage of the failed rails are from the upper part of the ingot than from the lower positions.

The committee reports separately on rails of special compositions. These include nickel-chrome steel, ferrotitanium bessemer, ferrotitanium openhearth, electric-process steel, and special openhearth. The committee gives no conclusion as to the greater or less reliability of these special rails.

Wear tests are reported from the Baltimore & Ohio with bessemer titanium; Boston & Albany, Boston & Maine, Chicago Great Western and other lines with bessemer ferrotitanium; Lackawanna with openhearth chrome-nickel, openhearth ferrotitanium and openhearth special; Lake Shore & Michigan Southern with manganese steel and ferrotitanium rails, as well as electric-process rails; Norfolk & Western with manganese steel; Pennsylvania R.R. with nickel-chrome steel and manganese-steel rails; Pennsylvania Lines West with high-silicon openhearth and electric-process steel; Rock Island, ferrotitanium and electric-process steel. In all these cases the special rails under test are laid with other rails for direct comparison. A number of results of these wear tests are quoted in the report, but they are conflicting and in no case point to marked superiority of one type of steel, or indeed of the special steel over normal rail steel. In this the wear tests agree with the breakage records, although the latter are far too few to permit a conclusion even as definite as this.

EDITORIALS

The Prosecution of Engine Runners Passing Danger Signals

The difficult task of trying to get absolute reliability of service from a large corps of employees is touched upon in a short article on another page, dealing with the prosecution of negligent railway employees in England. The writer of the article implies, though perhaps not in express terms, that railway operation would become safer if a few careless engine drivers were convicted of homicide. The same view has been advanced in this country, and juries have been scored for acquitting indicted railway employees in accident cases; but in this matter the English experience is instructive.

It appears that in England, where the absolute block-signal system is practically universal on railways and where consequently the danger signal has acquired a much greater degree of inviolability than in this country, there still are rare cases where an engineer runs past a danger signal. As is well known, the engineer endangers his own life every time he passes a stop signal, and he is well aware of what may be the consequences. It does not appear reasonable to assume that an engine driver would voluntarily and wilfully run the danger of sudden death. Doubtless what actually causes the engineer's wrong act is some slip of the attention, or temporary failure of co-ordination between the observing senses and the brain. Now the proposition is to apply a greater stimulant toward the prevention of such slips, or failures of co-ordination, by adding to the threat of death the further threat of jail.

It does not impress us as likely that the certainty of criminal prosecution, in case of so called culpable negligence, would have any greater influence in keeping locomotive engineers and flagmen fully tuned up to their duties than the stimulus which already exists in the risk of serious injury to themselves.

The English experience helps to prove an important proposition which, by the way, is perfectly obvious to anyone thinking the matter over in a reasonable manner. It is that in a very large series of operations by a great number of men 100% perfection is impossible. In the case of *routine* operation, and where numbers of men perform actually the same operation at the same time, thus producing a sort of interlocking effect, a near approach to perfection may be attained by severe and continued drilling, as in the handling of military forces. Where the operations are not routine, but involve intelligent control, and where all the other disturbing conditions obtain that differentiate such a matter as railway operations from military evolutions, the percentage of irreducible error must be larger. The human element in railway operation cannot be made infallible, even in England. Under American railway conditions, where stop signals are not absolute and the engine runners are encouraged to pass signals at danger, we must expect a larger proportion of faulty movements than in England.

Quantity Surveying in the United States

In Great Britain, "bills of quantity" always accompany the advertisement of bids for the erection of a building or the construction of any large work. Such a bill is furnished by the owner, architect, or engineer to the prospective contractor and professes to be a correct list of the quantities of work to be done and material to be provided. The contractor makes his bid, either with unit prices or as a lump sum, from this bill as a basis of quantity and with his own estimate of prices. In case he adopts the unit-price method any extras are, of course, taken care of automatically. If a lump-sum bid is made, the "bill of quantity," unless specified to the contrary in the contract, is merely supposed to be an estimate similar in that respect to the limited estimate of quantities sometimes made by the designing engineer or architect in American practice, but differing in that the estimate is very complete, and is made by a disinterested but qualified person known as a "quantity surveyor," whose profession it is to make just such estimates. The estimates then become close approximations of the amount of work to be done and can safely be used by the contractor in making up his bid. Of course, as a precaution he may go over the plans and specifications for his own satisfaction, for the estimate made by the quantity surveyor is not guaranteed and does not bind the owner unless the contract is so drawn. It nevertheless has the weight of disinterested authority, since the reputation of the man making it and consequently his professional standing depend on the accuracy of his estimates. Lump-sum bids made upon it, however, stand or fall by the contract and specifications and are not governed by the estimates.

In this country the "quantity surveyor" is not known. When occasionally the architect or engineer does condescend to present a list of quantities he specifically warns the contractor that the quantities are of little use. As a result each bidder on work is forced to go to the expense of making a detailed estimate of the quantities involved in the contract and the cost of this general estimating is not only assessed on the owner, but is also distributed among the many bidders as an economic loss. Furthermore, it often happens that the successful bidder has made only the roughest kind of estimate of the amount and on finding his bid under the cost of work attempts any and all kinds of skinning on the work in order to come out even or ahead of the game.

While in the largest kinds of engineering construction it is probable that the system of quantity surveying would be of little value, because the bidders on large work will undoubtedly wish to make their own estimates, in smaller contracts and in building work particularly, where it is easy to estimate from plans and specifications the exact amount to be used, the quantity-surveying system is a very good one.

For the above reasons we are glad to see that there is a prospect of quantity surveying being introduced into this country. There has been organized in San Francisco, under the direction of Mr. G. Alexander Wright, an architect of that city, an American Institute of Quantity Surveyors. This society issues a monthly bulletin from 571 California St., San Francisco, entitled *The Quantity Surveyor.*

The Institute is at present in only a formative state, but every effort is being made to increase its extent and authority. Local councils are being established in different cities and publicity campaigns to inform the average engineer, architect and contractor as to the merits of the scheme are being vigorously prosecuted.

Free Public Service by Engineers

We have so often emphasized in these columns the duty and the opportunity of the engineering profession to exert its influence for the wise solution of public questions that it seems proper also to emphasize in this place the fact that such work by an engineering society or its committees ought not to consist in giving out gratis professional knowledge, experience and skill which should properly be paid for.

Our attention is called to this matter by the receipt of a report concerning the work that a local engineers' club has done during the past few years for the benefit of the city where it is located. The report was prepared to refute the idea that the engineer does not make a fair contribution to civic work and states that the engineering society referred to is at present engaged on a project for the community's benefit involving millions of dollars expenditure.

The report states that some years ago the Mayor of the city was asked by a New York financial syndicate whether it was financially feasible to develop a certain water power near the city. The Mayor requested the local engineers' club to advise him what reply to make and the club appointed a committee of its most prominent members which made an investigation and report. Quoting from the statement sent us: "It is hardly necessary to state that there was no thought of making a charge for this service, which was a consultation matter of some magnitude." It is further stated that a pending project for land reclamation by the city was recently investigated by a committee of the club as to the manner in which the work should be carried out. Here again the services of the club's committee were rendered gratis.

In view of our frequent urging that engineers should participate in public affairs, we are confident that we shall not be misunderstood when we say that in our opinion, so far as may be judged from the circumstances above related, the club's action above described, however well intended, was unwise. It rendered a professional service to the public which if properly performed should have been paid for at a good price. We say this not merely because work done gratis in this way is done in competition with the private consulting engineer. A still stronger reason appears to us to be the fact that no work of this sort can be thoroughly well done unless an amount of time and study and expense is devoted to it that cannot possibly be given gratis by engineers who are large enough men in the profession to have their opinion worth while.

Take the first of the opinions above noted, for example. To render a reliable opinion as to the financial possibilities in the development of a water power would on the average require several weeks at least of thorough investigation by an engineer and a competent staff. Of course it may be said that there are cases where it is comparatively easy to give an off-hand opinion that a project is or is not feasible; but a water power development project involves so many elements which are at the present day subject to rapid changes in value that an engineer who does not thoroughly investigate all the aspects of a particular problem is in serious danger of making a mistake.

One of the clauses in the pending code of ethics for the American Society of Mechanical Engineers states that it is unprofessional for an engineer to render an opinion upon a subject without being fully informed as to all the facts relating thereto.

It seems to us that this rule is a useful one for the guidance of engineers and engineering organizations when such questions as those above discussed arise. If a committee of an engineering society, in fulfillment of what it deems a public duty, renders a report upon an engineering project, it should be clearly emphasized that the report is not meant to take the place of a technical report made by a commission to be paid a fair price for their work. In other words, the Committee should advise the public authorities where and how they can properly spend money for engineering advice rather than give them such engineering advice gratis.

As an illustration of the way engineers may properly exert their influence for public benefit we may refer to what happened in New York City nearly a dozen years ago. A project was brought forward by private capitalists to introduce an additional water-supply for the city under terms and conditions which apparently were very greatly against the city's interests. Prominent engineers of the city who were members of the Merchants Association exerted their influence to have the project investigated by the Association as well as the whole question of the city's future water-supply. A large fund was raised, committees were appointed on different aspects of the question and eminent engineers and lawyers were employed to render reports upon the project and advise what was the city's best interest to do with reference to its water-supply.

The influence of these reports upon public opinion was so great that the city itself undertook to investigate further and created a special board of expert engineers to investigate the situation *de novo.* On the strength of the report made by this board the city undertook the great Catskill water-supply work, which is by far the largest enterprise, measured in total outlay involved, ever undertaken by any city of the world with reference to its water-supply and ranks indeed with the greatest engineering enterprises that have ever been undertaken anywhere.

The point to be emphasized is that the prominent members of the engineering profession who first exerted themselves as public citizens in this matter rendered to their city an enormous public benefit, just as great a benefit as if they had undertaken themselves, at great personal sacrifice, to do the detail engineering work which the public, when the matter was properly presented to it, was willing and glad to pay for.

Why Not Use More Cement in Concrete?

No subject has attracted greater attention from engineers interested in concrete construction during the past two or three years than the question of the durability of concrete. For at least a generation it has been universally believed by the engineering profession that good concrete, properly made with sound cement, produced an artificial stone which was, at least as durable on exposure to the weather as a sound natural stone. The fact that a very large amount of concrete laid during the past ten years and exposed to the weather and to percolation, in retaining walls and elsewhere, is now showing unmistakable signs of great deterioration, gives engineers much anxiety.

Whatever theories may be held as to the effect of the quality of cement made by different mills and different processes upon such deterioration, there will be general agreement upon the proposition that if concrete is to be exposed to the weather, the less porous it can be made the better. Other troubles which have been experienced with concrete may likewise be traced to the porosity of the material. We may refer especially to the failures which have taken place in some dry docks where sea water percolated through the concrete and gradually weakened it, and also to the well known difficulties with sea walls of concrete between high and low tide in climates of heavy frost where the freezing of the water in the pores of the concrete between tides brings about rapid deterioration.

A vast amount of discussion has gone on concerning methods of waterproofing concrete by filling its pores with various materials, and millions of dollars have been expended during the last decade upon waterproofing materials. But a committee of engineers on the subject of waterproofing has gone on record with the declaration that about the best waterproofing is to make the concrete rich in cement. In structural work, too, a committee of engineers has expressed the opinion that cement is a cheaper reinforcing material for concrete compression members than steel, up to the limit of strength which can be obtained by merely enriching the mixture.

Taking all these things into consideration it occurs to us to raise the question whether engineers and contractors in general are not using too little cement in mixing concrete. There seems good reason to believe that we have been to a large extent continuing along in the old ruts of habit that were formed when cement was a high-priced material, costing $3 a barrel or more; and that at the present prices of cement prevailing in most localities, the added strength and durability to be gained by using a much richer concrete would be well worth all it would cost. Engineers have been content to accept lean mixtures of concrete because such mixtures when thoroughly made and set under ideal conditions of the laboratory show a very satisfactory strength. Among contractors, builders and workmen, too, the idea is strongly embedded that because even a very lean mixture of good cement with sand and stone sets up hard and firm it is, therefore, all right to economize in cement and make a little go a long way.

We believe that engineers, at least, will do well to sit down and reflect whether the use of lean mixtures of concrete in many places is not a case of saving at the spigot and wasting at the bunghole. Do most engineers and contractors fully realize how very little more it costs per cubic yard to make a very rich concrete instead of a good concrete? In order to demonstrate this we have compiled the accompanying little table showing the actual cost of the materials required for making one cubic yard of concrete of three different grades, namely, a 1:3:5, a 1:2:4, and a 1:1½:3 mixture.

QUANTITIES AND COST OF MATERIALS IN ONE CUBIC YARD OF RAMMED CONCRETE, USING STONE WITH 45% VOIDS, AND ASSUMING CEMENT COSTING $1.20 PER BARREL OF 4 CU. FT., AND SAND AND STONE EACH COSTING $1 PER CU. YD.

	Cement	Sand	Stone	Concrete
Proportions by parts.....	1	3	5	
Amount required for 1 cu.yd.....	1.16 bbl.	0.52 cu.yd.	0.86 cu.yd.	
Cost per cu.yd. for.....	$1.39	$0.52	$0.86	$2.77
Proportions by parts.....	1	2	4	
Amount required for 1 cu.yd.....	1.51 bbl.	0.45 cu.yd.	0.89 cu.yd.	
Cost per cu.yd. for.....	$1.81	$0.45	$0.89	$3.15
Proportions by parts.....	1	1¼	3	
Amount required for 1 cu.yd.....	1.91 bbl.	0.42 cu.yd.	0.85 cu.yd.	
Cost per cu.yd. for.....	$2.29	$0.42	$0.85	$3.56

We presume most engineers will agree that a 1:3:5 mixture is to be considered a first-class concrete. It is doubtful whether as much as 5% of the mass concrete used by engineers is mixed with any larger proportion of cement. The 1:2:4 mixture is at present limited to reinforced-concrete work and to other places where an engineer desires a specially dense and firm concrete for waterproofness or other reasons. The use of a 1:1½:3 mixture is limited, as far as we recall, to concrete paving specifications, and some few users of reinforced-concrete columns.

In the compilation of this table we have taken the quantities of material required in making the different concrete mixtures from the table on p. 232 of Taylor & Thompson's treatise on "Concrete," the percentage of voids in the coarse aggregate used being assumed at 45%. The cost of cement is taken at $1.20 per bbl. of 4 cu.ft.; the cost of sand and stone is asumed at $1 per cu.yd. for each. What we wish to show, however, is the small effect which the increased richness of the concrete has upon its cost per cubic yard; and the difference in cost between the different grades of concrete will be affected very slightly by variations in the cost of sand and stone. As the figures in the table show, the additional cost of a cubic yard of 1:2:4 concrete as compared with a 1:3:5 concrete is only 38c. To transform a 1:3:5 concrete into the very rich 1:1½:3 mixture costs only 79c. per cu.yd. for the additional cement.

It may be said that where the 1:3:5 mixture gives a material sufficiently strong, it is adding needless expense to put in the extra cement. This may be true where the material is put in as a foundation footing for example and is not exposed to deteriorating influences nor subected to extraordinary loading. But where the structure is a bridge through which water from the roadway will continually be percolating, or where the structure is a retaining wall whose face might suffer from the weather and the percolating ground water—in these and numerous other places—it would seem worth while to spend from 40 to 80c. per cubic yard additional for the sake of obtaining a solid, dense, water-resisting material instead of a more or less porous one.

When one considers that the average contract price of concrete per cubic yard in a finished work ranges from $4 or $5 up to $10 or $12 and even $20 or more on work

involving difficult form construction, one can appreciate all the better how well worth while it is to spend the small amount which the above table indicates is necessary to transform the ordinary concrete to the most dense, hard and waterproof mixture that can be obtained.

A very large amount of concrete is laid in positions where it is paid for at a price per square yard instead of per cubic yard. Sidewalks, street and roadway pavement and cellar floors may be taken as examples. If we assume, a 6-in. layer, then the added cost per square yard of 1 : 1½ : 3 mixture over a 1 : 3 : 5 mixture is only 13c. per square yard. Taking into consideration that the added strength of the richer mixture gives greater freedom from cracking as well as greater waterproofness and durability and will usually permit the use of one-course instead of two-course construction with a material saving in labor, and the case for the rich mixture becomes all the stronger.

It is true that mixtures of concrete materials may be made in the laboratory which will show a very great density with mixtures made only rich enough to fill the voids and give a small surplus over. But concrete construction is not a laboratory process by any means. Even with the greatest care taken by the engineer and the most thorough supervision of the work, the finished concrete will not be the uniform product which is turned out in the cement-testing laboratory. We do not by any means suggest that wasteful use of cement is to be resorted to in order to escape the results of careless work by the concrete gangs; but the engineer's business is to produce the best results at the lowest cost; and if we can save labor by spending more money for cement, as in using one-course instead of two-course work on paving, for example, there may be a gain in reduced cost as well as in better construction.

Some may argue that it is yet to be demonstrated that a richer and denser concrete would prove more desirable than the ordinary mixtures. It is undeniable that much of the concrete laid twenty years or more ago with the rather meager proportions then prevailing is today perfectly sound. Where failure of greater or less extent has occurred, however, the concrete is so often found to be porous that it is reasonable to believe a denser mixture would have had a longer life.

It will be evident, of course, that the figures we have given above are to be modified in any particular case according to variations in the cost of cement from that above assumed of $1.20 per bbl. The enormous productive capacity of the cement mills, however, is pretty fair assurance that the engineer can rely on generally moderate prices for cement prevailing in the future. He will do well to use the material liberally in his work and not risk its durability by any attempt to save a trifling amount in first cost.

LETTERS TO THE EDITOR

Jupiter Pluvius on Flood Prevention at Dayton, Ohio

Sir—It was with some fear and much consternation that I read in your issue of Oct. 16 the preliminary report on the flood-prevention methods which have been proposed by the engineers engaged by the city of Dayton. I read with some fear because the recommendations made, even though tentative only, may finally be adopted, and I read with much consternation because the plan which seems to meet with most favor will, if executed, plainly mark the beginning of the end of my self-appointed and agreeable work.

As the only original flood-maker, I feel much pride in doing a good job as often as I can and wherever I see that there is the most fun to be had. There is nothing I love better than to gather together in the clouds my myriad army of raindrops and then to send them hurtling earthward, each one intent and ready to do my bidding, each one as a good soldier eager to obey gravitation, the only law I have ever charged him with. Each soldier raindrop knows his task and knows it well. For him it is no new one. Obeying me, his commander-in-chief, he moves and lives and has his being in obeying his instructions. For him payday comes only when his work has been done, when he has swung the circle and returned once more to the foot of my nebulous throne. Thus it is that each raindrop hastens oceanward by the shortest and easiest path and with his comrades engages in battle against any and all materials which may tend to obstruct his path. But in particular my armies delight to charge and assault the thousands of sharp-cornered, clumsy and curious works which that presumptuous creature called Man has erected in, upon and over the highways which my army on its march to the sea must traverse.

For some decades now my generals on their return have told me of the bridge piers they have undermined, of the retaining walls they have caused to crumble, of the levees they have overtopped, of the houses they have wrecked, of the lives of men, of women and of children which they have carried on their shoulders far out into the ocean's depth. All of these tales have been as music to my ear, for they have borne witness that I am still able to assert my rights to those paths in which my Creator destined me and mine to travel.

Wherever Man in his all-wise and overbearing way obstructs the freedom of my hosts there do they give battle. When with levees he attempts to confine them, their efforts are directed toward escaping over the levee's top or through its mass, for well they know that once they gain the further side the sweetest of revenge will be theirs. Sack and pillage are my soldiers' due!

Wherever Man in his puny strength thinks to foil the will of my victorious army by shortening the way across some bend in its ancient route, then and there will my armies show their strength and cause to happen strange things which no human mind can foresee or predict. If for the moment foiled at such a place by such a thing, retribution will but follow fast and sure somewhere far-

ther down on the river's course and human sacrifice averted here will but directly lead to greater sacrifice elsewhere. My armies must be fed!

Wherever Man, smug in his self-satisfied cunning, thinks to foil my legions by deepening and by straightening the path they have learned to know and to love, then by strategy will my scouts and sappers fill up such deepening and replace the straightening by some more sinuous and more familiar route. Against me no such device can prevail!

And if, perchance, I send out to do my work an army which proves to be too small for keeping in order my God-given avenues to the sea, it then remains only necessary to next time send another and a larger. No legion which I have yet dispatched has been as large as that which I can and will some day send to do my bidding. Let Man beware!

How I dread to confess it! Strangely am I led to do so! All of my strength lies in my moving forces and if, perchance, they are held back and prevented from moving, then my proud banners will drag in the mud of the lakes which such holding back is sure to form. In motion there is no limit to my soldiers' strength. At rest, there is no limit to their weakness, and thus it is that I have heard with trepidation that Man at last seems to have found a way to master and overcome my proud and haughty power. Did Man but know it, he were my master! As yet, however, he is torn by theory, hindered by politics and heeding the voices of agitators, he is stumbling in the dark and it may be that he will miss the light. I pray that he will never corral my faithful men and store them in his reservoirs, for if he should adopt this means they and I would become his slaves and I would no longer glory in the destruction of the works of Man.

JUPITER PLUVIUS.

In the Clouds, Oct. 20, 1913.

Facts about Percolation from Canals

Sir—The article on "Seepage Losses from Earth Canals," by E. A. Moritz, in your issue of Aug. 28, 1913, was intensely interesting to me, as I have made many investigations along these lines and a rather exhaustive study of the subject.

The theory of seepage or percolation losses is ably put, and the mathematical demonstration is very interesting, but from a practical standpoint it is unnecessarily intricate and goes too much into refinements not justified by the working data. The uncertainty of the data to be obtained and the complication of the contributory causes of the seepage make any refinements of calculation useless except from a purely theoretical standpoint.

The seepage of water from a canal or reservoir is analogous to the flow of water in pipes. There must be some outlet, otherwise when the pipe is filled the flow stops and the hydrostatic head becomes equal to that in the canal. In the case of seepage from a canal, the outlet may be an underground gravel bed from which water is being drawn by wells, a surface drainage channel, either natural or artificial, surface soil evaporation, or plant growth. It may be, and generally is, a combination of all these, and the dissipation of the seepage water to its various destinations is analogous to the drawing of water from a main pipe line into various service lines. In flowing through the soil to the various outlets the water takes a certain gradient and when this gradient is reduced the flow is retarded, and should it become horizontal, the flow would cease. Moreover, the silting of a canal by deposition from the water carried, or the lining of a canal for the purpose of retarding the seepage losses, is analogous to the partial closing of a valve at the tank outlet.

Fig. 1 shows the parallelism of the flow of seepage water and the flow of water in pipes. The various soils have different resistances, and the hydraulic gradient will vary through them in the same manner as through a pipe line of varying diameter.

If there is no outlet by either underground or surface drainage the water table will rise until the soil evaporation strikes a balance with the canal seepage under the reduced gradient.

From the above it will be seen that it is difficult to obtain any set of coefficients for the various soils forming the banks and bottoms of canals, as the rate of flow depends on the gradient of the outlet, which, except where a regular drainage system is constructed, will vary constantly as the water table in the adjacent soil fluctuates. This is very apparent in the case of turning water into a new canal, or one which has been dry for a period. The seepage will be very great at first, gradually lessening until a balance is reached and the gradient of flow established to the ultimate outlet of the seeped waters.

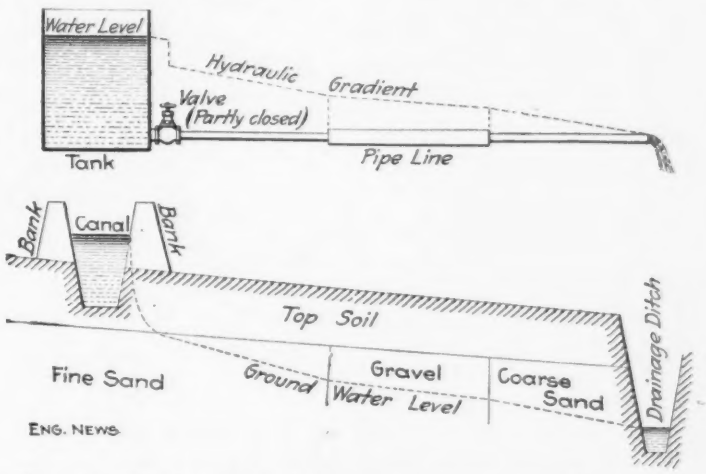


FIG. 1. PARALLELISM BETWEEN FLOW OF WATER IN PIPES AND FLOW OF SEEPAGE WATER FROM CANALS

Darcy's law of the movement of ground waters is applicable to the percolation of water from canals. He found that the velocity of flow varied directly as the pressure head and inversely as the depth, or length, of the soil column. This is expressed by the following formula:

$$V = c\frac{h}{l}$$

in which V is the velocity of the moving ground water; h is the head, or difference of pressure at the two ends of the soil column; l is the length, or depth, of the soil column, and c is a constant depending on the character and porosity of the soil.

For the purpose of obtaining the rate of flow of water through various permeable soils on which were to be founded dams and stopgates for irrigation works, I have made many tests with the type of apparatus shown by Fig. 2. The horizontal pipe A-B is rammed full of the soil to be tested and the water is admitted from the hose H and regulated by the valve C so that the proper

head is maintained by the overflow over the end of the pipe *D*. The percolating water flows out over the branch tee at *B* and is caught and measured in the vessel *G*. The quantity of water caught in a unit period of time, divided by the product of the cross-sectional area of the horizontal pipe by the percentage of voids in the soil tested, will give the velocity of seepage flow. Substituting this in Darcy's formula, together with the corresponding values of *h* and *l*, we are able to solve for *c*. This value of *c* I have found to range between 0.0001 and 0.0015 for the classes of soils which I have encountered in irrigation works in California.

The intermediate tees and standpipes at *E* and *F* are primarily to aid in filling the pipe with soil and making it compact. They are also useful for the purpose of taking intermediate readings of head, to ascertain from the hydraulic gradient if the filling of the main pipe has been uniform.

Variations of head may be obtained without changing the feed pipe by means of inclining the upright pipe *A-D* so as to give any pressure desired.

This apparatus has been used by me principally for the purpose of determining the safe lengths of seepage flow beneath irrigation structures. For this purpose I vary

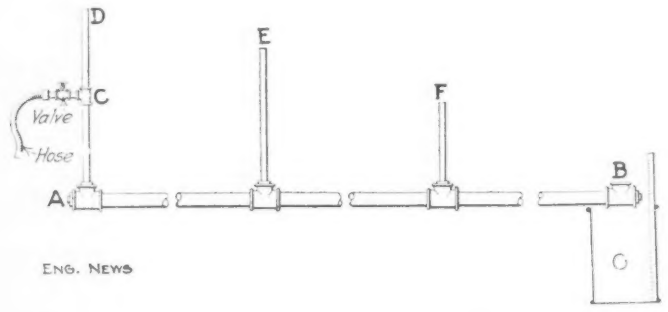


FIG. 2. APPARATUS FOR TESTING FLOW OF WATER THROUGH PERMEABLE SOILS

(Each length of pipe is first filled with the soil to be tested, which is made compact by tamping the soil while the pipe is in a vertical position. The pipe lengths are then screwed together and additional soil is tamped into the tees.)

the head *A-D* to determine at what velocity the soil will be eroded and carried by the seepage water over the outlet at *B*.

Investigations regarding seepage from canals are made at two times and for two different purposes. The first is during the original planning of the irrigation system, for the purpose of estimating the amount of seepage and the character of drainage works necessary, or the nature and expense of the preventative measures to be taken. Such an examination will consist of such soil examination as is necessary, with a proper consideration of topographical conditions, and of the geology as far as it is obtainable. The data will be more or less uncertain and the results will not be susceptible of great accuracy, but will be useful in a general way. A careful investigation along these lines will give results which would probably come within 50% of actual facts, whereas the whole range of seepage losses under different conditions may be as the ratio of one to ten.

The second class of seepage investigations is that made on a canal under operative conditions for the purpose of obtaining the amount of the seepage losses. This may be in order to determine the amount that the canals are contributing to the rise of ground water, or in order to see if the loss is sufficient to justify the expense of canal lining. In any case the exact quantity of loss may be determined for any period by actual measurement of the intake and deliveries over any section and for any length of time, and the rate may be obtained either by the method used by Mr. Moritz or by the more practical but less exact one of dividing the total quantity of seepage loss by the total area of water surface, obtaining the vertical depth of water lost by seepage. I see no advantage to be gained by reducing this to terms of second-feet per mile of canal, as in any case the total amount in second-feet or in acre-feet, according to the purpose for which it is to be used, is what is desired, and this is obtained from the original measurements without reduction. The vertical depth lost per square foot of water surface, obtained as above suggested, is useful only for purposes of comparison.

The loss by seepage from a canal is dependent on three main conditions: (1) the depth of water in the canal; (2) the porosity of the soil; and (3) the gradient of the percolating waters. The depth of water in the canal is dependent on the quantity of the intake, and on the regulation to the gates, which are generally so operated as to hold up the water level in different sections of the canal at different times for the purpose of serving different consumers. The porosity of the soil depends not only on the character of the original soil itself, but also on the amount of weed growth, and on conditions of sedimentation. The latter is itself dependent on the turbidity of the water and on the velocity of the current. The gradient of the percolating water is dependent on the fluctuations of ground-water level, and on drainage conditions, as well as on the soil evaporation, which is itself affected by cultivation and by plant growth. With all these contributory causes of seepage it is little wonder that we are unable to predict with more exactness what the seepage loss in a proposed system will be, or that the loss in an existing system will vary so essentially from season to season. I have found a variation from 0.34 ft. to 1.67 ft. vertical depth of seepage from different parts of a canal having the same characteristics of construction and operation and the same top soil, as far as appearances went, but different topographical and geological conditions. I have found a variation from 0.34 ft. to 0.46 ft. vertical depth of seepage from two adjacent canals having all characteristics the same except that one was clean and the other weed-grown.

The question of lining a canal to reduce seepage losses is one which should be approached from every angle. The benefits to be derived are the saving of water, the lessening of the danger of waterlogging the country below and the decrease of the canal section by increasing the velocity. Against these is to be balanced the cost of the lining. In many cases it will be found both cheaper and more efficacious to install a drainage system which will pick up much of the seepage from the canals as well as the water from over-irrigation and use it again on lower lands. The losses of water and the dangers of waterlogging are far greater from over-irrigation than from canal seepage, but that is a story by itself, which should be discussed under the head of "Irrigation Practice" (or Malpractice).

W. C. HAMMATT,
Consulting Engineer.
Hearst Bldg., San Francisco, Calif., Sept. 20, 1913.

The Collection of Patent Royalties from Towns and Cities

Sir—Your editorial on p. 617 of the Sept. 25 issue, under the caption "Protecting Towns and Cities from Blackmailing Patent Litigation" contains some admirable conclusions, but your assumed facts do not exist. On the subject of royalty, collections and suits, you are "about as near right as your left hand."

The State of Iowa has done a manly thing in passing a law authorizing the Attorney General to appear in behalf of defendants in patent suits. The reason you give for this law was not the real reason for its passage, although it *was* the *ostensible* reason urged before committees. Nevertheless, the law as passed by a sincere Legislature assumes a manly and generous attitude for the State.

In 1792 the Supreme Court of the United States decided that a State could be sued by a citizen of another State. (Chisholm vs. State of Georgia.) Immediately there was great activity among law makers and in 1794 the XIth amendment to the Federal Constitution was adopted. It provided that no State could be sued without its consent. From that day to this, 119 years, I can find no record of any State that has been sued or has given its consent to be sued for infringement of a patent, except the State of Iowa, which has now authorized its appearance as a *defendant* in equity suits. It is well established in equity jurisprudence that anyone who contributes to the assistance of a defendant, may be bound by the decree; and since the appearance is entered for the defendant, it must carry with it consent to be sued, even though it is not actual intervention.

Consent to be sued can, of course, be given only by the Legislature of a State. And since this law authorizing appearance, is the act of the Legislature, there is, therefore, an unquestionable consent by the State to be sued. It only remains to be seen whether the Governor and Attorney General will maintain that attitude when the time comes to actually make their first appearance in a suit.

This attitude of consent by a State to be sued is of great importance to patentees, as will be shown later. It is not in any sense inimical to their rights, and this is your sound conclusion in the editorial.

You say, however, that blackmailing claims must have caused the passage of this act. No better illustration to prove the very reverse could be asked for, than is found in the State of Iowa itself. For the State of Iowa has an association of cities banded together to resist payment of royalties under the Cameron Septic Process patent. Now the Cameron patent was for a basic idea, not a "trifling detail" of the kind objected to in your editorial, and the United States Circuit Court of Appeals held it valid, so that as to its merits, it was a valid patent. Upon an assumption of facts that the owner of the patent contends do not exist, and which were admitted in that one Iowa case only to expedite matters, the Supreme Court has held that the patent has since expired; hence this phase of its validity has not yet been thoroughly tested, but it is purely technical and does not relate to the merits of the invention.

The anti-Cameron association has expended nearly one-half as much in fighting the Cameron patent as would have been required to pay 10% royalty on all infringing structures. The effect of this litigation has been to encourage infringement and possibly to discourage the owner of a meritorious invention. Is this blackmail? It assuredly is, if your idea of what constitutes blackmail is correct. Opposition to the patent, moreover, developed before the patent had expired, under an assumption. And does not this contradict your statement that "No one will question the justice of demands for royalty on a valid patent"?

In the hands of the average owner, a patent is like the prize cow owned by the old Swede farmer and which was run over by a C., M. & St. P. train. The claim agent came to settle for the cow, and began to talk to the old farmer about the danger to traffic from stock running loose, hoping to bring the value of the cow down from a possible $500 to $50 or $100. After listening to the eloquent lawyer for half an hour, depreciating the value of the animal, the old farmer finally said, "Vell I tell you vat I do. I bane poor farmer, but I gif you two dollars, no more."

I have learned from experience that it is a practical impossibility to collect royalty from cities, towns or counties. Why *should* public officials pay a royalty, either on demand or to settle a suit? If they settle, they will be suspected of graft by their constituents. If they fight, they can at most be charged with bad judgment. The costs do not come out of the officials' pockets, but out of the public purse. And there are always attorneys to whom public officials are politically obligated who will be only too glad to defend patent suits, in order to get a "whack" at the treasury.

I have collected hundreds of thousands of dollars in royalties under the Luten Patents, but there has never been a cent collected by me or anyone else under these patents from any town, city, or county by suit or by threat, or by any other means, except under amicable contracts, previously agreed upon, for engineering royalty. It is true I have rendered bills for royalty on infringing structures, but I have received nothing but insults in reply.

You speak of the possibility of unprincipled owners of patents collecting considerable royalty by numerous suits, through a period of years without having their rights actually tested by the court. I take it you will admit that there is more possibility that these rights will be tested by numerous suits than by few. Your statement that suits may be won by sending them to trial against weak attorneys suggests the conclusion that the patentee should employ a "bum" attorney in order to give all defendants a better show. As for myself I endeavor to employ the best. If that be "unprincipled" make the most of it (with apologies to Patrick Henry).

The worst abuse of the patent system in the past has been in the delays in court; and these delays have greatly favored the defendant. Every country newspaper has advertised the fact that one of Edison's patent suits was contested for thirty years. Moreover, the burden of expense during suit is on the plaintiff and he has no public purse to dip into for his funds.

Under the old rules, prior to 1913, it was possible to delay a suit almost indefinitely, regardless of defendant's lack of resources, or attorney's lack of skill. I filed a suit in 1910 against a defendant who had *agreed* to pay a matter of two hundred dollars. The following year the defendant became bankrupt. Nevertheless his attor-

neys kept the case in court for three years at a cost to me of over $2000 and at one time offered to submit to a decree of injunction if I would pay their fees, amounting to less than $100. I refused of course, and the case is not yet disposed of.

I have been reliably informed that the entire cost of the suit against Saratoga Springs, N. Y., which established the validity of the Cameron patent exceeded $50,000; the defendant was assisted by an association of cities. I have also been reliably informed that the entire cost of the suit against the City of Owosso, Mich., which established the validity of the Warren bithulithic paving patent, exceeded $60,000; in this case the Barber Asphalt Paving Co. came to the help of the defendant. The New York Continental Jewell Filter Co. sued the city of Harrisburg, Penn., and numerous other cities joined the defense. The lower court has just decided against these combined cities, holding the patent valid and infringed. The Ransome Concrete Co. sued the German-American Button Co. and immediately numerous contractors with no direct interest, except a desire to infringe and to invalidate the patent, sprang to the assistance of the defense, although for fear of a decree they carefully concealed their identity from the complainant. The lower court found against them but the appellate court found the patent not infringed although valid. In all of these cases the capital *opposed* to the lone inventor was ten to one hundred times that of the complainant.

In 1910, I filed suit against a contractor who has since admitted under oath that he overthrew the first letting, in which he was *not* low bidder, through his "influence," by having a relative on the Board of Selectmen. The engineer has testified that the plan was traced directly from one of my own designs. The reinforcement specified and used was of smooth bars, nevertheless a prominent manufacturer of deformed bars appeared for the defense and has testified that he was paying the cost of the defense. Over a year ago I received a letter from this same manufacturer offering to permit a decree and injunction to be entered against the defendant *contractor* if I would grant him, the *manufacturer* of deformed bars, a free license under the Luten patents. I refused of course, and he is still contesting the validity of these patents, which he tacitly admits are good, since he has asked for a license under them. The costs in this case already aggregate $15,000; the amount of royalty involved was $330 and the contractor was first given an opportunity to settle for that amount but refused, as they invariably do.

My tale of blackmail is almost as good as yours, but mine is prosaic fact while yours has all the imagination of a real Hans Christian Andersen. In the patent cases that concern civil engineering, the combinations of capital seem to have been always on the side of the infringer and *against* the lone patentee. As for the patentee he is in the position of the young woman who was arrested for masquerading in man's attire. She was brought before the justice, who demanded to know where were her accomplices. Giving her trousers a hitch, she replied: "I don't need any, they stay up without."

Your editorial was based on the assumption that a suit for infringement is a suit for royalty. It is a suit for an *injunction* and the royalty is often a mere side issue, or basis for ascertaining the actual damage done by the infringement. You yourself have published the fact in a recent issue that no royalty has ever been collected from the City of Saratoga Springs by the Cameron Septic Tank Co. It was probably not worth the trouble. The injunction and decree of validity were the things desired.

A patent is granted for the express purpose of excluding others from its enjoyment. The only method of exclusion provided by law is by injunction, and before the patentee can enjoin he must be prepared to establish the validity of his patents against all comers. He must run the gauntlet through nine separate circuits, each with its Court of Appeals. What this means may be appreciated when it it understood that in the United States a patent is valid only when issued to the *original* inventor in this country. Because of this commendable provision which compels a patent in the courts to stand on its merits and not on any guaranty of the Patent Office, engineers and contractors have often assumed that an invention must be a tremendous innovation in order to merit validity; whereas the history of patent litigation shows that what might have been considered "trifling details" by the Patent Office, have in reality sometimes be come the cornerstone of an industry. The commercial success of a device often eliminates the "trifling" feature referred to by you.

Bell is credited with the invention of the telephone, and properly so; yet a telephone was almost complete before Bell attacked the problem. The diaphragm was old and even transmission of the human voice by an electric circuit was old. Bell merely adjusted a screw so that instead of a make-and-break contact with the diaphragm, a varying resistance was offered, and the telephone became a commercial success. To some of the Patent Office Examiners, the device seemed a mere toy and it was not then believed that business men would ever entrust business transactions to anything except writing that could not be changed. The stock of the telephone company was almost valueless at that time. In fact a printer in Boston after bringing suit for a printing bill, took some of the stock for services and then threw it aside as worthless. It subsequently became the foundation for a fortune. Yet to a Patent Office Examiner at that time it seemed a "trifling detail." It was in fact urged in an attempt to defeat the patent, that Bell's improvement was "trifling," but the Court recognized the "trifle" as the difference between failure and success.

The incandescent bulb was known before Edison. Edison changed the material of the filament and reduced its size; and he is now credited with the invention of the incandescent light and properly so, for he performed that last step necessary to make it a commercial success. But who could have foreseen this possibility?

Talking machines squeaked away for years until Hall supplied the fiber needle, substituting bamboo for steel. The steel needles soon render the records worthless. The fiber needle preserves them and libraries of records are now being collected that will last a lifetime. Over ten million of these trifling fiber needles have been sold in a single month.

It is often the "trifling details" that count. Particularly is this true *after* they become prized by others. Of what use is a patent on something that no one desires? The C., B. & Q. R.R. has paid $18,000 in settlement of a suit for infringement of a patent that was once looked upon as a "trifling detail" in reinforced concrete and

which engineers everywhere are infringing; and before settling the suit the railroad's attorney scoured the United States and Europe for evidence of anticipation. Opposition to a patent rarely develops until the patented device proves popular.

There are all degrees of resistance in patent suits and the hardest fight is apt to be made by the one least informed in such matters. He fights because he does not know enough to *know* that he has trespassed and hence thinks his cause just. And he has not been long enough in business to have learned the futility of spending his hard-earned money in litigation. I have filed 38 suits under the Luten Patents, and have already won 15 of them. The cost to me of these fifteen suits has exceeded by ten times the amount of money received in return, and not one of the suits proved profitable, except for the injunction and the respect occasioned for the patents, which have an unmeasured value far ahead of the cost. The average rating of the defendants in the above cases is greater than my own resources.

Litigation will not directly earn profits in royalties. But when patents have shown that they *can* earn royalties, then litigation may greatly increase those royalties from friendly sources. For why should anyone pay royalty if competitors may infringe with impunity? The whole purpose of these numerous suits under the Luten Patents is to properly protect those who have recognized their merit by accepting Luten Designs, and not for the collection of damages.

It is unfortunate that it is necessary under the laws to file repeated suits. One severely contested case would go farther in establishing the validity of a patent but it is practically ineffective in stopping infringement, except among those who are well informed. It is the fear of being compelled to contest a patent that is effective in preventing infringement. Numerous suits are useful in *dis*couraging infringement, not in *en*couraging it. And the distribution of printed decrees has this same object. If blackmailing litigation were profitable, an unscrupulous patentee would encourage infringement and at the same time would suppress all information regarding his suits.

It is because of the present necessity for repeated litigation that the action of the State of Iowa becomes important to patentees. If *one suit* is won against the State it will have the effect of fifty suits won against individual infringers and at less cost. Every move in such a contest, with the State involved, will be heralded abroad in the newspapers and the advertising derived will exceed even that from the full front page of ENGINEERING NEWS (with apologies to the Advertising Manager). Hence, it is to the best interests of all patentees to have the State of Iowa appear in behalf of the defense. Let us hope that other States will do likewise.

There is one rather commendable thing about the patents that are now earning royalties in the civil-engineering field, and many of which have perhaps seemed to vex the engineering profession. And that is that in almost every instance the patents are paying their own way. There have been no heavy accumulations of outside capital to litigate the Turner, Bone, Thacher, Parmley, Cameron, Warren, Ransome, or Luten patents. Almost without exception the costs of litigation have come out of the earnings of the patents, and no litigation was started until the patents had proved their merits by royalty earnings sufficient to provide the funds for their protection by litigation. All of the above patents are open to the public at reasonable established royalties.

You speak of the engineer being blamed for having designed an infringing structure. Should it not be a part of the engineer's business to know what patents exist in his field? Is he not supposed to know of property rights in connection with engineering design? From an examination of the advertising pages of the ENGINEERING NEWS I conclude that one-half of its income is derived from firms that use or sell patented devices. Patents must therefore be of importance to civil engineers. Invention means pushing back the boundary of science into the unknown. Scientific knowledge is becoming so vast that except in isolated cases none but the man trained in science may hope in future to invent; hence the inventor of the future will be the engineer. I question whether he will be a civil engineer until the profession assumes a different attitude toward patents from that of the hostile brand you have mentioned. Under present conditions the average civil engineer does not desire information regarding patents. Few engineering schools even mention the subject. So far as I know Cornell is the only college teaching patent law to engineers. One or two colleges even oppose patents virulently. Civil engineers take offense if offered copies of decrees bearing on the validity of patents in which they should be interested.

Is there any good reason for this? Why should a city engineer refuse to even look at a competing plan offered for a bridge and yet be offended when his attention is called to infringements in his own plans. I have known a city engineer to try to throw the responsibility for such infringement on the low bidder and when he declined to accept it, to offer it to the next bidder and to the next, until the contract was signed at 35% above the low bid; and the established royalty would have been but 10%. The public purse *can* be blackmailed but not by patent litigation.

The civil engineer is overlooking one of the best means for advancement of humanity, of his profession, and for himself, if he chooses to ignore patents and to permit other scientific men to monopolize one of the strongest incentives for discovery and advancement. If the civil engineering profession does not soon awaken to the value of patents on new inventions, it will be like the conductor who explained the slowness of his train by saying that it had lost time on the last run "and was behind before besides."

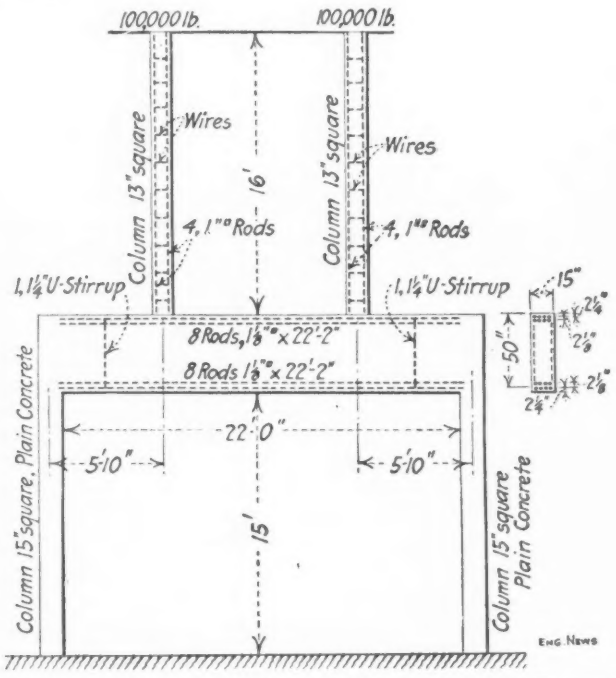
DANIEL B. LUTEN.

Indianapolis, Oct. 6, 1913.

[ENGINEERING NEWS has no quarrel and no intelligent engineer should have with the development of the arts and industries through invention and of the protection of inventions by patents. It is for the courts to determine whether or not a patent is valid, and our correspondent is entirely correct in his statement that an improvement in a small detail which spells the difference between failure and success may constitute invention and be properly afforded patent protection. It is equally true, however, that the misuse of the patent system, among other things by the collection of royalties upon patents which would not stand thorough sifting before a court is responsible for a large part of the popular opposition to patents.—ED.]

An Economical Concrete Design

Sir—I send herewith a sketch of a design for a girder and the columns which it carries, as well as the columns which carry it. I have worked up this design strictly in accordance with the rules of the report issued by the Joint Committee made up of members from the American Society of Civil Engineers, American Society for Testing Materials, American Railway Engineering Association, and Association of American Portland Cement Manufacturers. I think I have a very economical solution of this problem of carrying a very heavy load and spanning a wide space.



Economical Concrete Columns and Girder Designed after Joint Committee's Prescriptions

As this Joint Committee consists of thirty prominent specialists, I have reason to feel the utmost confidence in my design, though, of course, I may have made some error in my calculations. Perhaps some of your readers would like to check me up; if so, here are my main results: As the main columns are only 15 ft. high I found that a 15-in. square column at 500 lb. per sq.in. (the load allowed on plain shafts not over twelve times their diameter in height for 2220-lb. concrete) would carry 112,500 lb. The upper columns are 15 times their diameter in height, and the 13-in. square of concrete and 4 sq.in. of steel at 500 and 6000 lb. respectively, are good for about 108,000 lb. For the girder, $k = 0.348$ and $z = 4.37$. The unit-stress in the concrete is $M \div 1067$, or about 720 lb., and that on the compression steel is about 7020 lb. The tension steel stress is a little more than 16,000 lb., but inasmuch as the Joint Committee Report allows the use of 88,000 lb. steel, I do not see why they should confine the tension unit to 16,000 lb. With higher steel stress I could make the design more economical. The stirrup is explained in this way: The report allows stirrups to be spaced ¾ of the depth apart. This would be 37½ in., but as my single stirrup divides the space up into equal parts of about 3 ft., I used 3-ft. spaces in the formula. Taking two-thirds of the shear in the stirrups and $^{36}/_{50}$ of this in one rod, I found 52,800 lb. of stress in this stirrup. The 1¼-in. square rod bent in U-form is strained to a little more than 16,000 lb. per sq.in. in each branch of the U.

I do not wish to "bum" free engineering advice, but I think that anyone who will check up these calculations will be recompensed by these ideas of economic designing which cannot fail to impress him.

Subscriber.

Oct. 18, 1913.

Criminal Prosecution of Careless Railway Employees in Great Britain

By H. Raynar Wilson*

A very serious accident occurred on a British railway recently, which was caused by an engineer running by the distant and two stop signals at a tower, and running into another passenger train which had been stalled for want of steam. Sixteen lives were lost.

As an inquiry has reached me from America as to whether or not the engineer of the second train is being criminally proceeded against for carelessness, and as it is probable that the readers of Engineering News might wish to know what can be and what has been done in this and similar cases, I ask for space for a few notes on the subject.

Under the law of England all cases of sudden death, or of death from other than natural causes, are investigated by the coroner for the district, and a jury, and these of course include deaths from railway accidents. Should the jury return a verdict that such death is due to the culpable negligence of any person, this would be equivalent to a verdict of manslaughter and the police would then take criminal proceedings. An unusual but not unprecedented event arose out of the accident now under consideration. Due to the fact that of the victims 14 were killed outright, one died in hospital in Yorkshire, and one died later still in hospital in Cumberland, three inquests were therefore necessary. In the first inquiry the jury's original verdict put the blame for the accident on the engineer and fireman of the second train and the conductor of the first, but when asked whether culpable negligence was shown the jury replied in the negative, and an amended verdict of "Accidental Death" was returned. In the Yorkshire case a clear verdict of "Accidental Death" was returned. In Cumberland, however, a different result came about, as the engineer there has been considered culpably negligent, and has been committed for trial on a charge of manslaughter.

For a railwayman to be under an indictment for manslaughter is most uncommon. This is due to two reasons, the first of which is that fatal railway accidents in Great Britain are very rare indeed. In 1911 there were three, in 1912 four, and (so far) this year four. Out of these eleven mishaps three may be dismissed from consideration as being more or less of an accidental nature, and one was an error in block working for which one of two towermen was responsible but it was not clear which. In one case of the remaining seven a towerman was to blame, in one case a sectionman who was flagging in a dense fog, and in the remaining five the engineers ran past signals at danger. One engineer of these was killed, in two cases a verdict of "Accidental Death" was returned and in two there were verdicts of manslaughter, which

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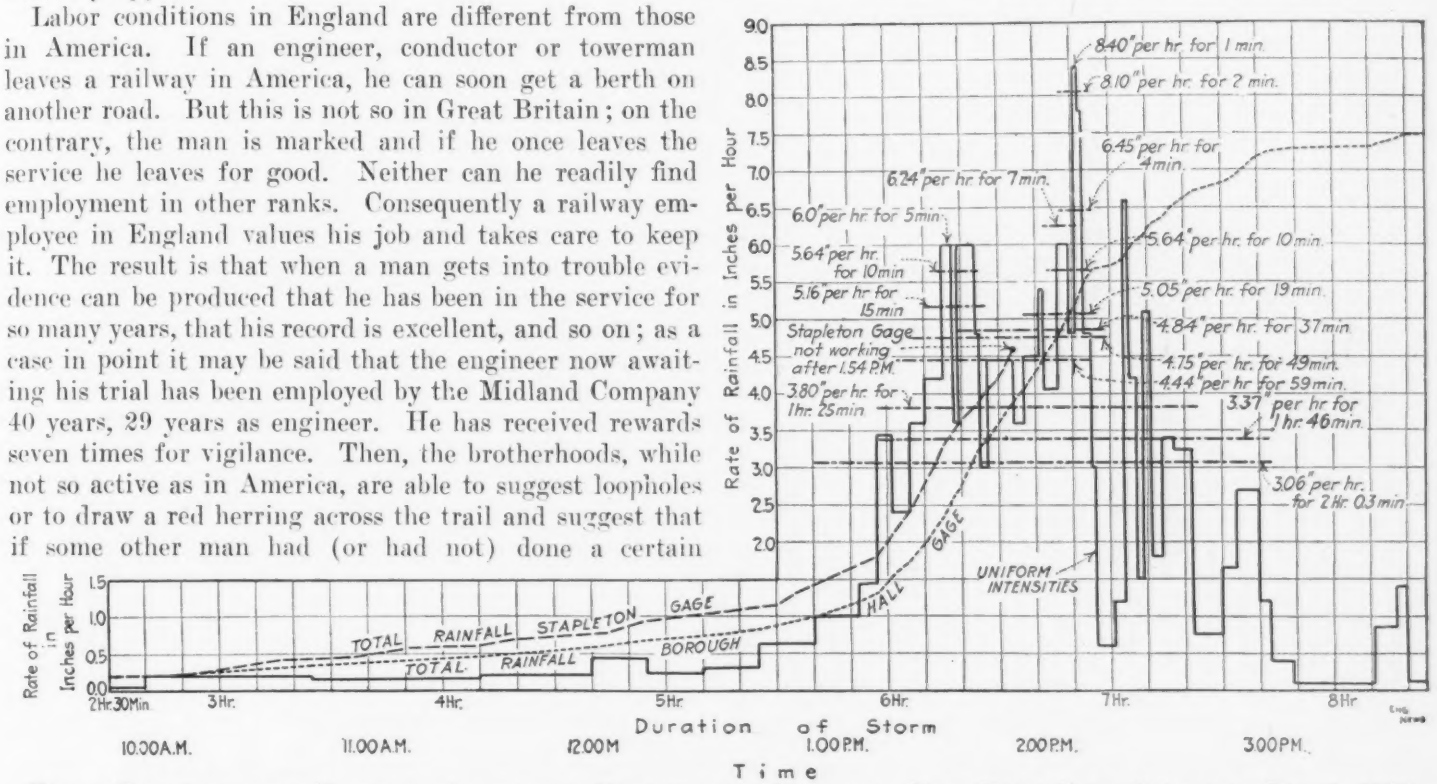
was also the result with the sectionman. It will thus be seen that out of 11 fatal accidents since the beginning of the year 1911, there have been three criminal prosecutions out of a possible six, one of which—the recent accident—has not yet been tried. In the other two prosecutions the men when placed on trial, were found "not guilty" and it is now desirable to suggest some explanation for this, especially as this will also account for the verdict of "Accidental Death" in cases where carelessness was very apparent.

Labor conditions in England are different from those in America. If an engineer, conductor or towerman leaves a railway in America, he can soon get a berth on another road. But this is not so in Great Britain; on the contrary, the man is marked and if he once leaves the service he leaves for good. Neither can he readily find employment in other ranks. Consequently a railway employee in England values his job and takes care to keep it. The result is that when a man gets into trouble evidence can be produced that he has been in the service for so many years, that his record is excellent, and so on; as a case in point it may be said that the engineer now awaiting his trial has been employed by the Midland Company 40 years, 29 years as engineer. He has received rewards seven times for vigilance. Then, the brotherhoods, while not so active as in America, are able to suggest loopholes or to draw a red herring across the trail and suggest that if some other man had (or had not) done a certain thing the accident would not have occurred. Lastly, the companies themselves help their men in such cases: they often furnish their bail, and as the conviction of one of their servants is a stigma on themselves they also search for ways of escape.

It may be added that British law allows railway employees to be prosecuted for carelessness even when no accident occurs—the very fact that life was endangered is sufficient. It is to be feared, though, that this is a dead letter, although a Board of Trade inspecting officer drew attention to it only a short while ago when a case of gross neglect occurred. Prosecutions have also been conducted under this law where, in a strike, men left their trains standing on the running track.


Rate of Rainfall in Inches per Hour
8.40" per hr. for 1 min.
8.10" per hr. for 2 min.
6.45" per hr. for 4 min.
6.24" per hr. for 7 min.
6.0" per hr. for 5 min.
5.64" per hr. for 10 min.
5.64" per hr. for 10 min.
5.16" per hr. for 15 min.
5.05" per hr. for 19 min.
Stapleton Gage not working after 1.54 P.M.
4.84" per hr. for 37 min.
4.75" per hr. for 49 min.
3.80" per hr. for 1 hr. 25 min.
4.44" per hr. for 59 min.
3.37" per hr. for 1 hr. 46 min.
3.06" per hr. for 2 Hr. 0.3 min.
HALL GAGE
UNIFORM INTENSITIES
TOTAL RAINFALL STAPLETON GAGE
TOTAL RAINFALL BOROUGH
2 Hr. 30 Min.
3 Hr.
4 Hr.
5 Hr.
6 Hr.
7 Hr.
8 Hr.
Duration of Storm
10.00 A.M.
11.00 A.M.
12.00 M
1.00 P.M.
2.00 P.M.
3.00 P.M.
Time

TOTAL RAINFALL AND RAINFALL INTENSITY, BOROUGH OF RICHMOND, NEW YORK CITY, STORM OF OCT. 1, 1913

(To bring the diagram into the space available the first and last periods of the storm, when the intensity rate was low, have been omitted. The intensity line rose quite uniformly from the beginning of rain at 7:20 a.m. until just before 10 a.m. and after 3:40 p.m. it continued to be uniform, at the rate shown, until the close of the record, at 5:40 p.m. At that time the total rainfall had reached 7.42 in., as stated in the text.)

The Remarkable Rainfall of Oct. 1, 1913, New York City

In our issue of Oct. 16, 1913, p. 781, the heavy rainfall which occurred in New York City on Oct. 1 was noted. We have since received from Louis L. Tribus, Consulting Engineer and Acting Commissioner of Public Works, Borough of Richmond, New York City, a highly interesting graphical record of the rainfall at the Richmond Borough Hall, which was considerably higher than the record for the Borough of Manhattan, mentioned above. The diagram, with the omission stated in its subtitle, is reproduced herewith. Mr. Tribus writes as follows:

The accompanying diagram shows the results of our rain-gage reading during the remarkable storm of Oct. 1, 1913, affecting the northerly end of the Borough of Richmond, between South Beach and West New Brighton; the rest of the borough did not seem to have received nearly as much storm water during this period. We believe that there is no record in this vicinity of such a storm. The total rainfall from 7:20 a.m. to 5:40 p.m., was 7.54 in. (equivalent to about 20% of the annual rainfall of recent years) in about 10 hours.

The diagram was prepared by J. C. Collyer, assistant engineer in the bureau of construction, Borough of Richmond. The amount of rainfall at each period was read and the time taken from a watch held by observers A. C. Clapp and Mr. Collyer. The gage in use for the whole period (one having gone out of service, as indicated on the diagram) was a Draper self-recording pluviometer, located on the roof of the Borough Hall, New Brighton, at elev. +145.36 above Richmond Borough mean high-water datum. The wind velocity was low from 1 to 3.20 p.m., the period of high intensity. The temperature was 62° F. at both 12 noon and at 4 p.m.

The excess of 2.26 in. rainfall within 24 hr. at the Richmond Borough Hall as compared with the record at Battery Park, Manhattan, only some five miles distant, shows the value of numerous stations when intensity of rainfalls is being studied.

A Steel Bridge of Continuous-Arch Type has been built over the Drau River at Marburg, Germany, and was recently opened for traffic. The bridge comprises three main arch spans of 131-ft. span each, made of girder ribs. The ribs of adjoining arches are continuous where they meet and are supported on the river piers by segmental roller bearings. The thrust is taken by the end abutments only. Unequal loading of adjoining spans producing differences in thrust must, therefore, be taken care of by distortion of the arches. The steelwork of the bridge amounts to 1000 tons. [Zeitschrift des Vereines deutscher Ingenieure, Oct. 4, 1913].

Annual Convention of the Association of Railway Electrical Engineers

The sixth annual convention was held at the La Salle Hotel, Chicago, Oct. 21 to 24, and in connection with it there was an exhibition of electrical appliances and supplies which occupied the entire top floor of the hotel. The greater part of the proceedings and most of the exhibits related to electric lighting.

ELECTRICAL EQUIPMENT OF DRAWBRIDGES—The committee on wiring for light and power submitted specifications for the electrical equipment of swing, bascule and vertical-lift bridges. The current may be obtained from some available line or generated at the site. The operating motors are usually of the railway or mill type, equipped with solenoid brakes. Direct-operated drum controllers are desirable up to about 50 hp. Beyond that, it becomes a question whether to use remote control, and such a system can be used efficiently where the voltage is 220 or lower. For small installations of less than 50 hp., the street-car type of drum controller is preferable; this has a separate handle for reversing, which gives the operator time to think of what he is doing before he reverses the operation of the bridge.

All motors on a bridge should be electro-mechanically interlocked, so that each operation must be made in sequence. This system must be interlocked also with the track interlocking machine, so that the bridge cannot be opened until the signals have been set at "stop." The equipment should include a motor-driven air-compressor for charging a tank, the air being used to operate a whistle and the emergency brakes. Lighting is not very important, except as to the navigation lamp signals and the lamp signals indicating the position of the locks and end lifts and the movements of the bridge. The specifications accompanying the report covered the cables, wiring, instruments, etc.

LIGHTING RAILWAY YARDS—This committee recommended liberal lighting at switches and a general illumination for the entire yard. In planning new yards, consideration should be given to the location of poles for lighting, with the necessary track clearance. Railway yards usually cover such a large area that a series lighting system is best adapted to meet the requirements, and such a system may have flaming arcs, carbon-filament or tungsten lamps. The first lamp has the advantage of the penetrating effects of the yellow rays, which is important where smoke is a serious condition, and it can be used with direct or alternating current, but the cost of maintenance is high and the light distribution is not good. The second has advantages in long life and good light distribution, being specially suitable for lighting large areas, but its use is restricted to direct current. The third is the most flexible, and can be used on any series circuit with lamps of various candle-power. To light a large area, a number of units can be placed on one pole, the size or number of units being selected to meet requirements.

For carbon-filament lamps of not less than 7.5 and metallic-flame lamps of not less than 6.6 amperes, the committee recommends a spacing of not over 375 ft. for general yard lighting and not over 250 ft. for switch lighting, with a height of not less than 32 ft. and preferably 42 ft. above the rails. For tungsten lamps of 200-watt size, the spacing should be 125 ft. for general illumination, and closer for special illumination (as at switches), with a height of 20 to 25 ft. above the rails.

Wood poles are recommended on account of their low cost and of the fact that yard tracks are frequently shifted, necessitating the moving of the poles. The butts of the poles should be treated. Concrete poles are expensive, but for general outdoor work it may be desirable to use them under special conditions where the track layout can be considered as permanent. Steel poles and structures probably offer the greatest advantage where long spans are necessary, but inspection and painting will be expensive. They should be set in concrete, and if they carry high-tension circuits they should be grounded, and the grounding should be inspected frequently. Under ordinary conditions a pole spacing of about 125 ft. is recommended, with a minimum clearance of 5 ft. 8 in. from the gage side of the rail to the pole, and 25 to 30 ft. from the rail to all overhead lines.

CAR LIGHTING—The committee on head-end equipment stated that all the roads using the head-end system (with steam-generating plant on the train) have now adopted 64 volts, as recommended by the association. The report outlined the practice of half a dozen railways in the equipment, operation and maintenance of these installations. The Northern Pacific Ry. is experimenting with an axle-driven head-end equipment of sufficient capacity to light an entire train, most axle-driven systems being for individual cars. The committee on dynamo suspensions referred to some improvements in these suspensions for axle-driven plants, and the committee on standards outlined experiments on methods of increasing the life of tungsten lamps, while another committee presented methods of charging storage batteries for car lighting.

The report of the committee on illumination dealt with tests as to the arrangement, sizes, etc., of lamps in the cars, and the use of reflecting and diffusing appliances. It appears that in efficiency, distribution and absence of shadows equally satisfactory results are given with lights in the center of the deck roof or on each side of the deck, but the lights should not be spaced more than two seats apart, about 6 ft.

MISCELLANEOUS—A paper on "The Gas-Electric Car," by L. C. Joseph, Jr., described this type of railway motor car, with its equipment and performance, but made no reference to specific results on any railway. There was a paper also by T. V. Buckwalter, on "Electric Trucks for Handling Freight."

Specifications were submitted for the crossing of railway lines by electric transmission, lighting and power lines having potentials above 100 volts. These included overhead and underground crossings, and also crossings carried beneath bridges. Specifications for wire and cable have been prepared in coöperation with the American Electric Railway Association. The committee on locomotive headlights presented a digest of laws in 28 states. Such laws have been drawn evidently without due consideration as to standards of tests, while some of them tend to prevent the introduction of more efficient apparatus. The committee expressed the opinion that the prime object of such laws is to obtain a certain quality and quantity of illumination at some specific point, and not to require certain means or apparatus by which such illumination may be obtained.

American Railway Bridge and Building Association

The 23d Annual Convention of the American Railway Bridge and Building Association, held at Montreal, Can., occupied the best part of the three days from Oct. 21-23. It was the second convention of the society which has been held in Canada, the other being in Quebec, ten years ago. The attendance, however, was fully equal to that of previous meetings in the United States, the larger part of the members present coming from the States.

The meeting was presided over by the President, A. E. Killam, Moncton, N. B., late of the Intercolonial Railway. For the ensuing year the following officers were elected: President, J. N. Penwell (Lake Erie & Western Railroad, Tipton, Ind.). C. A. Lichty (Chicago & Northwestern Ry., Chicago, Ill.), was continued as Secretary, and J. P. Canty (Boston & Maine R.R., Boston, Mass.) as Treasurer. The convention voted to hold the next annual convention in October, 1914, at Los Angeles, Calif.

Committee Reports

The work of the society is done entirely through committee reports, 13 of which were on the schedule for the present convention. Of these, seven were in print at the convention, two were presented in manuscript form, and four were passed over without any report.

Water-Supply—The Committee on Water-Supply (Chairman, C. R. Knowles, Illinois Central R.R., Chicago, Ill.) presented a report on the subject of water-supply for railways, including a discussion of the various methods of pumping, and some data on the cost of pumping. The report was preceded by a general paragraph on the amount of water used by the railways, but was practically devoted to the comparison of the various types of engines used in pumping. Figures were given, showing the increased cost in gasoline and the reasons for this increase, and recommendations made for the study of the adoption of various other types of fuel-oil engines. Some limited tests on the relative efficiency of engines using different types of fuel oil were given, and finally the results of a test were shown on a comparative efficiency of a vertical-steam boiler, a return-tubular steam boiler, and a fuel-oil engine.

The discussion was mainly upon the advisability of using old locomotive boilers in the smaller pumping stations. Most of the discussers stated that their management insisted upon the use of old locomotive boilers for small stations, and although such boilers might not be as efficient as a new boiler, still the relative first cost made the problem one of accounting, which it would be hard to decide, except in individual cases. The chairman, however, insisted that no matter how cheaply a locomotive boiler could be gotten, it was not cheap to operate, and that as a rule its cost would be higher than a new return-tubular boiler. Several members stated that for small plants electricity and gasoline are much cheaper than steam, particularly because one man can operate three or four pump houses, thus reducing labor costs and maintenance. The report was accepted as a progress report.

Sewers and Drains—(Chairman, R. O. Elliott, Louisville & Nashville R.R., Nashville, Tenn.) The committee submitted some details of a layout for sewers and drains, particularly for railway building. The details were mainly made up from letters of inquiry, giving the practice of various railways. The results obtained are not different from those in general sanitary engineering practice.

Temporary Structures—The committee on temporary structures for supporting tracks during construction of permanent work, sewers, etc. (Chairman, W. C. Whitney, Boston & Albany R.R., Boston), had prepared a summary of the answers received to a letter of inquiry sent out to members of the society, requesting practice in the method of supporting tracks during a construction which necessitates excavation or tunneling under the tracks. The answers were quite varied, so varied, in fact, that it was difficult for the committee to prepare any standard answers, giving the general practice of the railroads.

On the basis of the majority report, the committee made certain recommendations which may be abstracted as follows:

1. Piles should be driven before stringers are put in. 2. In cases where there is a choice of piles, frame bents or crib work, as a general rule piles should be used. 3. When the bottom is soft, where there is the slightest chance of scour, piles should always be used; they should be driven at least 4 ft. below the bottom of the proposed excavation. 4. Where local conditions permit, span lengths should be the same as standard trestle spans, which will permit using stringers from stock, or second-hand material. 5. For spans longer than safe timber construction, I-beams or girders are recommended. 7. Whenever stringers only are used, they should be supported on cross sills at the end, except when width of excavation is small compared to length of stringer. As a general rule, the depth which can be excavated is such that a 1½ to 1 slope from each side of the bottom of the excavation will not undermine the sills under the ends of the stringers. 8. A detour trestle should be put in when a suitable alignment of track can be obtained. Rolling in a bridge is recommended when conditions will permit. Where it is not permissible, and the new bridge must be rebuilt in place, it is recommended that the old metal floor system be left in and the falsework designed with this in view. 9. Where bottom is uneven, short sills should be used, where possible, unless the bottom is rock, in which case the sills may be omitted entirely. All bents should be well braced. 10. Wooden scabs placed on temporary work, securely spiked or bolted, are recommended; also runner timbers, or girts, in all cases at every break in the uprights.

The committee was in doubt with regard to when excavation should be undertaken, and when tunneling. General discussion on the subject showed that above a depth of 30 ft. it is customary to tunnel. R. H. Reid (Lake Shore, Michigan & Southern R.R., Cleveland, Ohio) cited a case where tunneling was made through a 40-ft. fill, under a four-track main line road, and traffic was maintained at full speed over the tunnel during all construction. This tunnel was timbered with old 8x8-in. ties. It was 180 ft. long and no movement of the tracks was noticed at any time.

Snow Fences—(A. H. King, Oregon Short Line Ry., Salt Lake City, Utah). As a result of the circular letter sent to members, the committee expressed the opinion that where conditions prevent the placing of snow fences in advantageous position, no benefit and much harm may result from their use. The report may be abstracted as follows:

The first essential in the use of snow fences is that there shall be sufficient space between the cuts and the nearest string of fence to prevent the drift formed by the fence from extending into the cut. Experience based on personal observation during one severe winter will enable one to decide upon the proper location of the fence. It should, of course, be placed as nearly windward of the cut to be protected as possible. A second string of fence should be placed far over the first and far enough away that its drift will not

ordinarily lap over the first, and additional strings of fence, if required, should be located in the same manner. In high elevations on the Union Pacific the company sometimes places as many as five rows of fence, 150 to 250 ft. apart.

A departure in snow protection has been undertaken by the Great Northern Ry., which is planting trees in eastern Montana, North Dakota and Minnesota. This tree planting has proved a very effective means of protection against wind blowing across the track. The same effect is produced where sage brush or any other form of vegetation provides a lodgment for the snow. The report contained a diagram of the kind of trees and method of planting adopted by this railway.

The report recommends a portable type of snow fence, which can be taken down in the summer.

PRESERVATION OF TIMBER—(Chairman, G. W. Rear, Southern Pacific Co., San Francisco, Calif.) The report of this committee is intended to bring up to date the reports which had been presented to the same society each year from 1904 to 1908. In addition to the progress report, however, the committee thought it wise to incorporate in the present report a discussion of the entire subject of timber preservation. As a result the report is a very good abstract of the whole subject. It, however, contains little that is new on wood preservers nor much that had been brought out from the experience of the members of this society.

CATTLE GUARDS—(Chairman, A. Ridgway. Denver & Rio Grande Ry., Denver, Colo.) As a result of inquiry this committee discovered that there was a diversity in the various states as to the legal status of cattle guards, and furthermore that different railroads operating in the same states seem to have different opinions regarding the statute. However, in the Eastern States, where there is a smaller amount of public domain, the requirements for cattle guards are much more stringent than in the West, where the public domain is large and where also the grazing areas are so great that the cattle roam over much larger territory. It is certain, however, that there is no legal protection afforded by the installation of stock guards, and where stock is killed contemporaneously with the maintenance of guards in good condition, claims are legally allowed on the assumption that the guards are not effective barriers, although in perfect order. It also appears that neither the approval of type by railroad or public-utilities commission, nor conformity to statute requirements and design, relieves the railroad from responsibility for stock killed.

The committee concluded that the modified pit guard, consisting essentially of deep cross ties so spaced in proportion to their depth as to afford no knee room for an animal taking a step, is the best construction. The patented or special guard with floor construction which might injure stock, was considered of secondary value. It was further reported that there is no absolutely effective guard entirely free from objectionable features, but that the wooden, flat-surface guards embody a minimum of objectionable features and are probably just as efficient as most types of metal-surface guards.

Two tests were reported in the discussion in which cattle were kept on one side of a guard and feed in large quantities placed on the other. It was reported that no guard in either test was impassable to the stock.

FIRE-RESISTING COATING FOR TIMBER—(Chairman, Lee Jutton, Chicago & Northwestern Ry., Madison, Wis.) The committee reported on the test, the preparation of which was noted at the last convention in Baltimore. These tests consist of coating some specially built pile timber structures with various types of fire-resisting coating and placing hay and other imflammable material under the structure and setting fire to it. Observation was then made upon the length of the time it took for the fire to catch the pile structure and also upon the relative resistance of the structure to the flame so engendered.

Ten coatings of different commercial types were applied to the pile structure. In every case except one, the fire caught in the timber structure inside of five minutes and effected nearly complete destruction of it in a short length of time. In the one case the fire seemed to lose its hold after a while, and finally died out before complete destruction. However, the next day after the tests were made, all of the wreckage of the ten structures was gathered together in one pile, including the structure which was not destroyed, and a bonfire made of the lot. At this time, complete destruction of all the timbers was effected. As a result of the test, the committee reported that there was available no absolute fire-resisting coating, although all of the coatings tested were fire-retardent to some extent, and the one which is noted above was superior to the others. This one consisted of two coats of water paint, which took six hours to apply, and one coat of oil, which took four hours to apply.

In the discussion, considerable objection was made to the test, in that it was much more severe than actual conditions. In defense, however, the committee stated that such conditions actually occur in many cases, particularly in the Far West, where pile structures over small depressions very frequently become filled with grass which, after drying out in the summer, becomes ignited, subjecting the timber structure to such a fire as was had in the test. In the discussion it was also brought out that any fire-resistant or retardent paint on the market would act to prevent a fire from coals dropping upon the timber of a trestle. Many members reported that in a number of cases they had found burnt traces of dropped coal, but that never had they noted a fire which had resulted from such dropped coals. It was a general opinion of the meeting, expressed in discussion, though not by motion, that it was advisable in all cases to use some fire-resisting coating to protect against dropped coals, although it was not to be hoped that such coatings could serve to retard or prevent fires from burning straw or hay, or weeds.

MOTOR CARS FOR BRIDGE GANGS—(Chairman, R. C. Young, Lake Superior & Ishpeming Ry., Marquette, Mich.) A brief report on this subject recommended very strongly the use of motor cars for bridge-repair gangs. These motor cars have been pretty extensively used by section hands, and their use is growing for bridge gangs. It was reported that where they have been used, an increased efficiency of from 30 to 50% has been noted. The cars, as now built, are quite reliable. Certain specifications for the construction of the cars were made by the committee, among which was that they should be light, being under 1000 lb., that they should have the same speed in either direction, that they should have a maximum possible speed of 20 miles, and that they should be simple in design. While there was some discussion on the speed question, some members holding that there should be an allowable speed greater than 20 miles, for the use of higher officials, when needed, while others maintained that anything over 15 miles an hour on a

low motor car is dangerous, the report of the committee was accepted.

TRACK SCALES—(Chairman A. M. Van Auken, Chicago, Rock Island & Pacific Ry., Shawnee, Okla.) This committee submitted to the association a report of which the Secretary was able to get into type 125 pp. He reported, however, that there were a number of appendices, photographs and drawings which he had not been able to get into type, and that the cost of getting the report into its present form was so great as to be one of the leading reasons why there was a deficit in the funds of the society for the first time in many years.

The report starts out with a historical description tracing the use of weights and measures and scales back to the early Egyptian and Babylonian days, up to the modern American practice. There are a number of pages describing the details of modern scales, both those manufactured by the railways and those patented by scale companies. Then follow some pages on the requirements of design in track scales, comparisons of the different types of scales, kinds of material to be used, and many pages describing some typical track-scale installations. Extracts are given from the specifications of the American Railway Association and of the State of Minnesota, as well as much material upon the maintenance and adjusting of scales, and upon the organization of the scale department. The committee submits a suggestion for a scale specification, based upon certain other specifications which have been used. Finally, the report contains reprints of several articles in relation to track-scale work.

An extensive discussion followed the presentation of the report by Secretary Lichty. This discussion was not based upon the material which is in the report, for that material was not in the hands of the members present until a few hours before the report was presented, but was based upon the advisability of accepting and printing the report. The parliamentary procedure at this point was so confused as to make it difficult to be sure of just what was done, but so far as one on the floor could say, the motion adopted was that the report be accepted as a progress report, the committee continued, and that the committee confer with the American Railway Association (which has also a track-scale committee) as to some disputed points in the report. After the agreement of the two committees, the report should be printed in the proceedings of the association.

OTHER COMMITTEES—The following committees made no report: Equipment and Tools for Bridge Gangs, Concrete Culverts and Various Kinds of Pipes for Culverts; Heating, Lighting and Ventilation of Roundhouses and Shops, Concrete Posts, Poles and Signs.

FUTURE SUBJECTS

The Committee on Future Subjects presented the following subjects for consideration at the next convention: 1. Ice houses and the preservation of ice for railway service. 2. Warnings for overhead obstruction. 3. Railway-crossing gates, towers and other devices for highway-crossing protection. 4. Construction of reinforced-concrete bridge work, particularly the field work. 5. Station building for passenger service only (small stations, not large terminals). 6. Mechanical coaling stations. 7. How to take care of traffic while constructing bridges to eliminate grade crossings.

Lower Prices Promised for Lumber

With the opening of the Panama Canal, Oregon fir timber and lumber can be shipped into the New York market at $12 to $14 less per M. ft. than prevailing quotations. The Isthmian Canal Commission has been paying, on an average, $19.35 per M. for Oregon fir delivered at the Isthmus. On Oct. 18, a quantity of timber to be delivered at Balboa was offered at $16.35. This was specified to be Oregon fir. The base price at Pacific Coast points is now $10.50.

The Corps of Engineers, U. S. Army, received bids in Chicago, Sept. 5, for furnishing approximately 800,000 ft. of timber ranging from 6x10 in. to 12x12 in. and including less than 100,000 ft. of 4x12 planking, and the price quoted was $8.40 per thousand f.o.b. points in Oregon and Washington.

The overland freight rate on fir timber by rail for less than 40-ft. lengths from Pacific Coast points to New York is $24 per M. ft. For sticks longer than 40 ft. the rate is $26.40. On shipments by steamer via the Isthmus of Tehuantepec the present rate is $17 per M. ft., but this is unsatisfactory because at times it is difficult to secure berth room. In a recent article in the "American Lumberman," Robert Dollar, president of the Robert Dollar Steamship Co., San Francisco, Calif., estimated that the average rate on lumber shipments from American ports on the Pacific Coast to New York would be $11.38 per M., and shipment from British Columbia to New York could be made at $9.18 per M., the difference being due to the lower cost of British ships. It is possible that even this rate can be bettered, although one company operating boats between San Francisco and the Isthmus (a company which will operate a through line) states that the rate on fir timber will be about $12 per M. Even this, however, would mean a price f.o.b. New York of $23 to $25 per M. ft. for Oregon fir timbers of any size up to 12x12 in. and 40 ft. long, and a price of $20 to $22, New York, for boards. Long-leaf yellow, until recently, sold at $32@40 per M. in New York. With the opening of the Barge Canal in New York it is possible that Oregon fir can be shipped through the Panama Canal, reloaded at New York and shipped on barges through the New York State Canal to Buffalo, then by way of the Great Lakes as far west as Chicago before all-rail rates seriously compete with the water rate.

NOTES

A Coal-Mine Explosion at Dawson, N. M., at 3 p.m., on Oct. 22, in Mine 2 of the Stag Cañon Fuel Co., from causes unknown, entombed about 285 men. Press dispatches state that about 22 men were rescued alive, 165 bodies have been recovered and 98 are still missing. Following the explosion, fire broke out in the workings adjoining No. 2 and reached the latter mine where it is said to have been controlled.

A Broken Rail wrecked the Gilt-Edge Express on the New York, New Haven & Hartford R.R., at Westerly, R. I., on Oct. 26. When the six cars rolled over the embankment 20 persons were injured. According to an official statement by the New Haven, the wreck "was caused by a broken rail, due to a graduated concealed fissure at right angles to the axis of the rail." The broken parts of the rail, which is claimed to have been rolled and placed in 1910, were turned over to the Public Utilities Commission of Rhode Island for examination.

Investigation of the Staten Island Boiler Explosion, which occurred on Oct. 21, at the plant of the Richmond Light & R.R. Co., at Livingston, S. I., disclosed that the boiler, which was of the vertical Wickes type, rated at 300 hp., had been washed out on the day of the accident and put into service 10 min. before the explosion took place. The failure occurred in the bottom head of the boiler due to fatigue of the metal at the point where the head is flanged-up to join the drum. The direct cause of the failure is not known. It is significant that three years ago Wickes Bros., believing that the boilers were not receiving proper attention, offered to buy them back, but the offer was refused. The result of the accident (as far as service is concerned) was that Staten Island was without electric light for five nights.

The Mont D'Or Tunnel on the Frasne-Vallorbe line between Dijon and Lausanne, giving an improved connection from France to Switzerland, was holed through on Oct. 2, 1913, after very great difficulties in construction had been overcome. This tunnel is intended primarily to improve the westerly approach to the Simplon Tunnel by shortening the line and reducing the difficulties of the crossing of the Jura Alps, and, thereby make a more attractive competing route to the Lötschberg route. The tunnel is 20,000 ft. long, or between 3½ and 4 mi. The two portals were attacked in the fall and early winter of 1910, and after the first stage compressed-air percussion drilling was used in the heading advance. The builders counted on holing through in the spring of 1913, but difficulties attendant upon the enormous inflow of water in the latter part of 1912 and in the current year caused the six months' delay. Little or no detailed news concerning the difficulties has been allowed to get into the public press. After the completion of the tunnel and the opening of traffic through it, a statement of the difficulties and how they were overcome may be expected.

A Factory Fire in the two adjacent six-story buildings at 206-212 Canal St., on Oct. 24, caused the death of eight of the inmates. The fire was started by two almost simultaneous explosions in the factory of the Royal Machine Works, on the third floor of the building at 210 Canal St. The explosion of a gas stove under an oven containing an oily fluid used in japanning metals, was followed by the explosion of the fluid. Large quantities of combustible chemicals in the machine works and in the Metropolitan Mirror Works, at 206 Canal St., which adjoined the former, caused the fire to burn fiercely, and the two buildings were gutted. An impressive feature of the fire was the efficacy of the high-pressure pumping system, which was discussed in "Engineering News," May 30, 1912. Although the fire lasted four hours, the tenement houses which surrounded it were prevented from igniting, as were also the ground floors of the buildings.

An Industrial and Technical Education Conference has been organized in Philadelphia, as a section of the Public Education Association of that city. The membership is to consist of teachers and employers, and the aim is to seek the solution of problems arising from the needs of large numbers of young people there, who have never had proper opportunities to secure knowledge which will help them to better service and higher responsibilities in work. This is a result of a recent meeting of all of the industrial, technical, and trade schools in the city, with the Philadelphia and Camden public schools, for similar purpose. It is believed that the development of capabilities of the people whom it is desired to help, will in most cases depend on what possibilities their employers bring to their attention and make available. Among the questions to be considered are: what courses are needed; how much time can be required of busy men for school work; what fees are suitable; how shall those be accommodated who have long distances to travel; should classes be established in shops or offices remote from schools but under the control of trained faculties; what kind of education will best help certain employees; which employees can profit most by systematic school work; how can the employer help the employee to get the training?

Forth Bridge Floor Repairs—The stringers and floor plates on the Forth Bridge are to be renewed, and replaced by stronger sections, according to an editorial account in "Engineering" of Oct. 3. The roadway of the bridge has under each rail a trough-shaped stringer about 18 in. wide and 18 in. high, made of three plates and four angles; timber stringers carrying the rails are seated in the troughs. Since the completion of the bridge in 1890, locomotive weights on the North British Ry. have increased more than 50% in total weight, and 25 to 30% in axle load. Nevertheless, says the editor of "Engineering,"

> while there is no present reduction in strength for the supporting of the load, and still a thoroughly adequate margin of safety for increase in size of locomotives in the immediate future, the directors have decided to prepare timeously for probable development, and have arranged, as we have already stated, to re-lay from end to end a part of the floor and the trough carrying the inner rail in both up and down lines.

The reference to inner rails is due to the fact that on the larger part of the bridge only the two middle rails of the four (of two tracks) are supported on trough stringers, the outer two resting directly on the top flanges of the secondary trusses. In the suspended spans, and in the sections of the cantilever arms near to the suspended spans, there are four trough stringers, but on these sections the work of replacement is to be done later. It is stated that some 2500 tons of steel is involved in the renewal work, and of this, 750 tons is additional material.

Grain Elevator Sinks Into the Ground—On Saturday, Oct. 18, the reinforced-concrete binhouse of a new Canadian-Pacific Ry. grain elevator at Transcona, near Winnipeg, Man., started to settle into the ground and continued its slow subsidence for 24 hr., till Sunday noon. Its final position was tilted about 30° from vertical; the west long side settled the most, while of the opposite side one corner showed little settlement. A low concrete cupola containing conveyors extended over the binhouse, and when the house had tilted as above described the cupola broke or slipped off, falling to the ground on the side of maximum subsidence; this occurred about midnight Saturday. The binhouse was nearly full of wheat (about one million bushels).

The elevator plant comprised a headhouse or working-house, and alongside this the binhouse of the usual high-bin type. The latter consisted of five rows each of 13 circular bins, a total of 65 bins, its longer direction extending north from the working-house. Each bin was 14 ft. inside diameter by 90 ft. high. The triangular spaces between bins were also used for grain storage. The conveyors in the cupola led to the working-house, whose machinery stories extended above the level of the top of the binhouse. The working-house did not settle, but remained vertical, with little or no injury so far as we are informed at present. The binhouse rested on a reinforced-concrete slab about 12 ft. below ground surface. The foundation load was 2½ tons per sq.ft. The soil under the foundation must have squeezed out laterally, as the ground on both sides and the north end, for 25 ft. away, bulged up. Yet the working-house, only 10 ft. south of the binhouse, remained plumb. The binhouse foundation is raised several feet at one corner and is about 30 ft. down at the diagonally opposite corner. The bin walls did not suffer any apparent injury in the settlement; the house settled like a solid block. The grain is being removed by tapping the bin sides, and there may be only slight loss on the grain. Barnett-McQueen Co., Ltd., of Minneapolis, Minn., built the elevator in 1912.

The Cucaracha Slide on the Panama Canal, which was illustrated on p. 667 of our issue of Oct. 2, has proved quite an obstacle to the flooding of the Culebra Cut at the southern end from the waters of Gatun Lake. As already recorded in these columns, on Oct. 10 the Gamboa dike at the northern entrance to the Culebra Cut was blown up, giving the waters of the lake free access to the cut. As was made clear by the photographs above referred to, the Cucaracha Slide in the last two months has formed a huge dam, extending clear across the cut and high enough to prevent the water at its present stage from flowing across into the south end of the cut. To open an outlet for the water, a force of men was put to work on Oct. 6 excavating a trench across the top of the slide. Successive downward movements of the sliding material, however, kept closing the trench at points and it was then decided to dynamite a gap in the barrier with the expectation that the water would rush through the gap and maintain a clear channel. Dynamite to the amount of a ton and a half was therefore placed in the toe of the slide and exploded at 4:15 p.m., Oct. 10. A channel was made for the water but before any considerable amount could pass through, the material of the slide flowed in and closed the break. Additional blasts were tried, but with similar results, and so work with pick and shovel was resumed on the following day and by Sunday, Oct. 12, a stream of water was flowing through. It required a force of 200 shovelers, however, aided by two heavy water jets in order to keep the channel open. By Oct. 14 a stream 6 to 8 ft. wide and 1 ft. deep was flowing across the barrier at a velocity of about 10 ft. per second. On the north side of the slide the water was about 69 ft. above sea level and on the south side about 43 ft. The material in the slide is a sticky clay intermixed with stones up to 2 ft. in diameter, so that it is not eroded readily by the flowing water.

The Horse Shoe Bend Dam on the Bow River, near Bassano, Alberta, had its gates closed on Oct. 20, 1913. The dam is a part of the great 800,000-acre irrigation project of the Canadian Pacific Ry. extending eastward from Calgary for nearly 150 miles (see "Eng. News," Apr. 27, 1905, for a general description of the project as it then stood; also Aug. 8, 1912,

p. 247, for a progress sketch of the enterprise based on a visit by a member of the editorial staff of this journal). The dam has a total length of 8000 ft., but this includes a part of the canal headworks, a hollow reinforced-concrete dam across the river 720 ft. long between abutments and an earth embankment stretching up one side of the river some 7000 ft. until the natural rise in the low bank of that side of the river attains the elevation of top of the main dam, where it abuts on the high bank of the other side of the river. This embankment has a maximum height of 45 ft., maximum top and bottom widths of 32 and 310 ft., respectively, a wet slope of 4 to 1, a dry slope of 3 to 1, and contains a round million cubic yards (all these figures as given in the the summer of 1912). The hollow concrete dam has a maximum height of 40 ft. to the overflow crest, above which rise piers to support 24 structural steel Stoney gates, each 27 ft. in clear span. These raise the water 11 ft. above the overflow crest, or to a total height of 51 ft. The dam was designed and built by the Ambursen Hydraulic Construction Co., of Boston and Montreal, for the Natural Resources Department of the Canadian Pacific Ry., which is headed by J. S. Dennis, assistant to the president. A. S. Dawson, Calgary, is chief engineer of the Department, and H. B. Mucklestone, of Brooks, is assistant chief engineer. Harry Sidenius, of Bassano, was resident engineer in charge of construction on behalf of the Canadian Pacific. W. L. Church is president and H. L. Coburn is chief engineer of the Ambursen Co. named, and G. E. Heckle is chief engineer of the Canadian Ambursen Co. All these and John R. Freeman, consulting engineer, Providence, R. I., were present when the gates of the dam were closed, as were Mr. Fraunchofer, division engineer of the project, and W. Nasmythe, land agent of the Natural Resources Department.

PERSONALS

Mr. J. D. Stack has resigned as Division Superintendent of the Oregon-Washington R.R. & Navigation Co., at Portland, Ore.

Mr. F. W. Kane, Office Engineer of the Missouri, Kansas & Texas Ry., has been promoted to be Assistant Chief Engineer, with headquarters at Dallas, Tex., and his former office has been abolished.

Mr. W. L. Wroe has been appointed Assistant Superintendent, at Houston, Tex., of the Texas & New Orleans R.R. and the Galveston, Harrisburg & San Antonio Ry.

Mr. Myron G. Doll has resigned as Manager of the Salt Lake City, Utah, office of the Sullivan Machinery Co. He is succeeded by Mr. H. E. Moon, recently with the Denver office of the company.

Mr. E. S. Heyser, General Superintendent of the San Benito & Rio Grande Valley R.R., San Benito, Tex., has resigned to become Division Engineer of the St. Louis, Brownsville & Mexico Ry., with office at Kingsville, Tex.

Mr. Frank E. Getts, Assoc. Am. Inst. E. E., formerly Engineer at the Chicago, Ill., office of the General Electric Co., has been appointed District Sales Manager of the Chicago office of the Alberger Pump & Condenser Co.

Mr. H. E. Passmore, Master Mechanic of the Toledo & Ohio Central Ry., has resigned to become Vice-President in charge of sales of the Eastern district of the Grip Nut Co., of New York and Chicago. Mr. Passmore will keep his present headquarters at Bucyrus, Ohio.

Mr. P. W. Early, M. Am. Soc. C. E,, has resigned as Chief Engineer of the Virginia-Carolina Ry. and the New River, Holston & Western Ry., to return to his former position as Manager of the Mason & Hanger Co., Contractors, with headquarters at 410 Trust Bldg., Lexington, Ky.

Mr. Philip E. Harroun, M. Am. Soc. C. E., has resigned his connection with the California Railroad Commission, as Engineer of the division of hydraulics, and has resumed his former practice as Consulting Hydraulic Engineer, with offices in the Holbrook Bldg., San Francisco, Calif.

Mr. C. A. Shoemaker, Assistant Superintendent of the Chicago Great Western R.R., at St. Joseph, Mo., has been promoted to be Superintendent of the Southern division at Des Moines, Iowa, succeeding Mr. W. B. Causey, who has been transferred to the Northern division at St. Paul, Minn.

Mr. Frank Holmes, Assoc. M. Am. Soc. C. E., formerly Assistant Engineer of the Thompson-Starrett Co., New York City, and Superintendent for the company on the Woolworth Building construction, is now Assistant Engineer on building construction under the Isthmian Canal Commission, Culebra, Canal Zone, Panama.

Mr. C. P. Collins, Assoc. M. Am. Soc. C. E., recently Engineer, Berwind-White Coal Mining Co., Windber, Penn., has opened an office at 401 First National Bank Bldg., Johnstown, Penn., as Civil and Mining Engineer, specializing in reports on mineral lands, installation of bituminous coal plants, valuation of mining properties, etc.

Mr. Dana C. Douglass, recently Assistant to the President of the Maine Central R.R., at Portland, Maine, has been promoted to be General Manager in charge of the operating department. Mr. Douglass was born at Leeds, Maine, in 1877, and his railway experience began in 1894 as a stenographer to the General Manager of the Maine Central R.R.

Mr. Charles Evan Fowler, M. Am. Soc. C. E., President of the International Contract Co. and the International Dredging Co., Seattle, Wash., has opened an office as Consulting Engineer for the design of bridges, structural work, foundation, seawalls, wharves, dredging, river and harbor work and heavy engineering construction in steel, concrete or timber, at 504 Central Bldg., Seattle.

Mr. F. B. Clapp, for some time with the engineering staff of the General Electric Co. in San Francisco, Calif., has been appointed Engineer in charge of the suburban electrification of the Victorian Rys. at Melbourne, Australia. Mr. Clapp is a native of Australia. He graduated in electric engineering from the Worcester Polytechnic Institute in 1905 and has since been with the General Electric Co.

Mr. A. G. Wells, General Manager of the Atchison, Topeka & Santa Fé Ry., Coast Lines, has returned from his six months' leave of absence, and Mr. I. L. Hubbard, General Superintendent, who has been Acting General Manager, has returned to his former position. Mr. J. R. Hitchcock, who has been Acting General Superintendent, has returned to his former position as Division Superintendent at Los Angeles, Calif.

Mr. Herman Rettinghouse, Superintendent of the Iowa and Minnesota divisions of the Chicago & Northwestern Ry., at Mason City, Iowa, has been appointed Chief Engineer of the Chicago, St. Paul, Minneapolis & Omaha Ry., at St. Paul, Minn., succeeding Mr. C. W. Johnson, resigned, as noted elsewhere in these columns. Mr. Rettinghouse was formerly Division Engineer of the Chicago & Northwestern Ry., at Boone, Iowa.

Mr. Jonathan Jones, Assoc. M. Am. Soc. C. E., recently Engineer, Pottstown plant of the McClintic-Marshall Construction Co., has been appointed Assistant Engineer, Bridge division of the Bureau of Surveys, Philadelphia, Penn., succeeding Mr. H. H. Quimby, M. Am. Soc. C. E., who was recently appointed Chief Engineer of the Department of City Transit ("Eng. News," Oct. 9). The salary of Mr. Jones' position is $4000 per annum.

Second-Lieut. W. M. Chubb, Corps of Engineers, U. S. A., who enjoys the distinction of being the only engineer officer of the army who is not a West Point graduate, has been promoted to be First-Lieutenant. Lieut. Chubb is the son of Col. Chas. St. J. Chubb, U. S. A.; he is a graduate of Ohio State University, class of 1907, and was Examiner of Surveys in the General Land Office when he received his commission in the Corps of Engineers in April, 1912.

Mr. Robert Farnham, Jr., M. Am. Soc. C. E., recently Assistant Engineer, Pennsylvania R.R., at Philadelphia, Penn., has been promoted to be Assistant to the Engineer of Bridges and Buildings. Mr. Farnham graduated from Lehigh University in 1899 and for several years was with the engineering department of the District of Columbia. Later he had charge of the construction of the tunnel of the Washington Terminal Co. under the Capitol grounds at Washington.

Mr. Robert Spurr Weston, M. Am. Soc. C. E., Consulting Sanitary Engineer, Boston, Mass., has been appointed Assistant Professor of public health engineering at the Massachusetts Institute of Technology, succeeding Mr. Earle B. Phelps, Assoc. Am. Soc. C. E., resigned, as noted in our issue of Oct. 16. Prof. Weston graduated from Amherst College in 1891 and afterward took post-graduate work at the Massachusetts Institute of Technology and at the University of Berlin, in Germany.

Mr. Augustus Kempkey, Assoc. M. Am. Soc. C. E., Consulting Hydraulic Engineer, of San Francisco, Calif., has taken over the office and practice of the late Arthur L. Adams, M. Am. Soc. C. E., in the Balboa Bldg., San Francisco. Mr. Kempkey is a graduate of the University of California, class of 1902, and had been associated with Mr. Adams for several years as Assistant Engineer of the Contra Costa Water Co., on various irrigation projects, and as Assistant Engineer of the Peoples Water Co., Oakland, Calif.

Prof. Warren O. Laird, M. Am. Inst. Arch., Director of the department of architecture at the University of Pennsylvania, has been appointed Consulting Architect to report upon a

comprehensive plan for the further development of the University of British Columbia, Vancouver, B. C. Prof. Laird will act jointly with Prof. R. J. Durley, M. Can. Soc. C. E., of the engineering department of McGill University, Montreal, Que., Thomas H. Mawson, Landscape Architect, London, England, and Messrs. Sharp & Thompson, resident architects at Vancouver.

Mr. C. W. Johnson has resigned as Chief Engineer of the Chicago, St. Paul, Minneapolis & Omaha Ry., at St. Paul, Minn., to become Consulting Engineer of the company. Mr. Johnson will be 69 years old in January and has been Chief Engineer of the Chicago, St. Paul & Minneapolis Ry. and its successor, the Chicago, St. Paul, Minneapolis & Omaha Ry., since Mar. 1, 1879. He was born at Johnstown, N. Y., in 1845, and graduated from Union College, Schenectady, in 1866. He entered the railway-engineering service in 1867 in the Assistant Chief Engineer's office of the Michigan Southern & Northern Indiana Ry. During the interval 1870-79 he was Engineer of Construction, Assistant Engineer and Division Engineer of various early railways centering in Chicago.

Col. William C. Gorgas, Assistant Surgeon General, U. S. A., Chief Sanitary Officer of the Panama Canal Zone, accompanied by Mrs. Gorgas, arrived from Colon on Oct. 20, at New York City, from whence he will go to Johannesburg, South Africa, to make investigations and recommendations regarding the sanitation of the district of the consolidated mines of the Rand, at the request of the companies in the consolidation, which employ about 200,000 men. Col. Gorgas and his assistants, Maj. Robert E. Noble and Dr. S. T. Darling, have been granted four months' leave of absence to accomplish this work. In January of the present year, Col. Gorgas received a similar appointment in connection with the investigation of the port of Guayaquil, Ecuador. Col. Gorgas is quoted by the New York "Evening Post" as follows:

> The trouble is the high death rate from pneumonia among the negroes. The district affected is a strip about 60 miles long, in the center of which is the city of Johannesburg. I expect to arrive there about Dec. 1, stopping on my way to study conditions at the Kimberley mines. After a month in South Africa, we shall leave for the Isthmus early in January, possibly going by way of Buenos Aires.

Governor Tener, of Pennsylvania, has appointed the following members of the Suburban Metropolitan Planning Commission, which is to make comprehensive plans for systems of transportation, highways, roads, parks, parkways, water supply, sewerage, sewage disposal, garbage disposal, housing, playgrounds, sanitation and civic centers in the territory adjacent to Philadelphia: Messrs. Alba B. Johnson, of the Baldwin Locomotive Works; George W. Elkins, Jr., a capitalist and traction official; Charles O. Kruger, President and General Manager of the Philadelphia Rapid Transit Co.; John Gribbel, a capitalist and manufacturer; John R. Grundy, a manufacturer, of Bristol; Julius E. Nachod, a brewer of the firm of Class & Nachod; George Sullivan, of Lower Merion, a manufacturer; Penrose Robinson, a publisher; Arthur P. Townsend, a business man, of Langhorne; Marshall R. Pugh, M. Am. Soc. C. E., of Pugh & Hubbard, Civil Engineers, Philadelphia; Emile J. Berlet, of Ridley; Samuel F. Houston, a capitalist; A. Merritt Taylor, Director of the Department of City Transit, Philadelphia; Randal Morgan, a director of the United Gas Improvement Co., and William S. Ellis, of Bryn Mawr.

OBITUARY

John S. Fackenthal, M. Am. Inst. M. E., a noted iron founder of Pennsylvania, and formerly connected with the Consolidated Lake Superior Co., Sault Ste. Marie, Ont., died Oct. 22, aged 51 years, at his home in Easton, Penn.

Luther R. Zollinger, M. Am. Soc. C. E., Engineer of Maintenance-of-way, Pennsylvania R.R., died Oct. 21, at his home in Merion, Penn. He was born in 1865 and graduated from Lehigh University in 1888. His railway experience began the following summer as a rodman with the Assistant Engineer of the Pennsylvania R.R. at Harrisburg, Penn. He was promoted to be transitman in 1891, he was Assistant to the Assistant Engineer of the Philadelphia division from 1891 to 1895; from 1895 to 1898, Assistant Supervisor and later Supervisor of the Norristown-Schuylkill division and the Philadelphia division. In May, 1902, he was made Assistant to the Principal Assistant Engineer at Altoona, Penn., and in November, 1903, he was promoted to be Principal Assistant Engineer at Altoona. Since 1905 he had been Engineer of Maintenance-of-way.

ENGINEERING SOCIETIES
MEETINGS

NATIONAL CONSERVATION CONGRESS.
Nov. 18-20. Annual meeting at Washington, D. C. Secy., T. R. Shipp, Indianapolis, Ind.

GREAT LAKES INTERNATIONAL PURE WATER ASSOCIATION.
Secy., Paul Hansen, Urbana, Ill. Meeting postponed until further notice.

UNITED STATES GOOD ROADS ASSOCIATION.
Nov. 10-16. Third annual meeting at St. Louis, Mo. Secy., J. M. Rountree, Birmingham, Ala.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 2-5. Annual meeting in New York. Secy., Calvin W. Rice, 29 W. 39th St., New York City.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Dec. 1-2. Annual meeting in New York Secy., W. H. Reed, 154 Nassau St., New York City.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS.
Dec. 8-11. Annual meeting in New York. Secy., Percy H. Wilson, Land Title Bldg., Philadelphia, Penn.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Dec. 9-12. Annual convention at Philadelphia, Penn. Secy., W. H. Tolman, 29 W. 39th St., New York City.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Dec. 10-13. Annual meeting in New York. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Dec. 11-12. General meeting in New York. Secy., D. H. Cox, 29 W. 39th St., New York City.

American Road Builders' Association—The business at the convention to be held at Philadelphia, Penn., in the First Regiment Armory, Dec. 9-12, will be considered under three general heads: Organization, construction and maintenance. It is probable that the papers and discussions will occupy five sessions. A popular session will be held on the evening of Dec. 11, when prominent men interested in highway betterment, will speak.

American Society of Civil Engineers—The following list of nominees for the offices to be filled at the annual meeting, on Jan. 21, 1914, received from the Nominating Committee, was presented to the Board of Direction at its meeting on Sept. 3, 1913. The list has been mailed to all corporate members: President, Hunter McDonald, Nashville, Tenn.; Vice-Presidents, Charles F. Loweth, Chicago, Ill.; Gardner S. Williams, Ann Arbor, Mich.; Treasurer, John F. Wallace, New York City; Directors, Arthur S .Tuttle and George W. Fuller, New York City (District No. 1), Charles H. Keefer, Ottawa, Ont. (District No. 2), Mortimer E. Cooley, Ann Arbor, Mich. (District No. 3), Eugene E. Haskell, Ithaca, N. Y. (District No. 3), and Richard Montfort, Louisville, Ky. (District No. 5).

Richmond (Va.) Society of Engineers—The first general meeting of the society, which but recently was organized, was held on Oct. 16. The objects of the society are to afford opportunities for engineers in the several branches of the profession to meet one another, the holding of meetings for the reading and discussion of professional papers, the discussion of topics of general interest, and for the maintenance of an engineering library. The present membership consists entirely of active members, but provision is made for three other grades—honorary members, associates and juniors—the last two making it possible for men engaged in the allied sciences and for the younger technical men to participate in the meetings. There are at the present time about 53 members who represent in fair proportion the different branches. The president is Arthur Scrivenor and the secretary, James Bolton.

Western Society of Engineers—At the meeting held at the Society's rooms, in Chicago, on Oct. 13, a paper on the reinforced-concrete grandstand at the grounds of the University of Chicago was read by W. Hodgdon, the architect. The paper was descriptive mainly and did not discuss the engineering features of the design. An interesting feature of the work was that the concrete wall surrounding the grounds was built horizontally in sections on forms which were later swung up to set the wall in a vertical position.

At the meeting on Oct. 20, a paper on "Water Filtration in Illinois," by Dr. Bartow and Mr. Hansen (director and engineer, respectively of the State Water Survey), was read by the former. This showed that there are now 33 filtration plants (including two for the removal of iron), and the first of these was built in 1886. The majority are gravity plants, only four operating under pressure. The paper was followed by a description of the filter plant now being built at Evanston, Ill., a number of views of the plant being shown by Langdon Pearse, one of the engineers.